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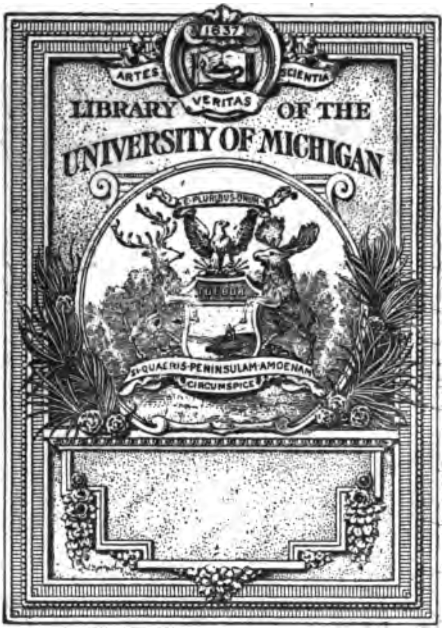
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ASSOCIATIONS
OF
GAS ENGINEERS AND MANAGERS
—UNITED KINGDOM—

ASSOCIATIONS
OF
GAS ENGINEERS AND MANAGERS
—UNITED KINGDOM—

REPORTS OF PROCEEDINGS
DURING
1898
OF THE
Eastern Counties Gas Managers' Association,
Manchester District Institution of Gas Engineers,
Midland Association of Gas Managers,
North British Association of Gas Managers,
North of England Gas Managers' Association,
North of Ireland Association of Gas Managers,
Scottish Gas Managers in Glasgow,
Southern District Association of Gas Engineers and Managers,
AND
Waverley Association of Gas Managers.

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REPORTS OF PROCEEDINGS.

ASSOCIATIONS OF
GAS ENGINEERS AND MANAGERS
—UNITED KINGDOM—
1898

SOUTHERN ASSOCIATION.

ANNUAL MEETING, FEB. 10.

This Meeting was held at the Holborn Restaurant.

At the commencement of the proceedings, the chair was occupied by the retiring PRESIDENT (Mr. James W. Helps, of Croydon), who introduced his successor, Mr. R. Beynon, of Torquay.

CONFIRMATION OF MINUTES.

The PRESIDENT having taken the chair, the minutes of the general meeting held in the previous November were confirmed.

ANNUAL REPORT OF THE COMMITTEE.

The HON. SECRETARY (Mr. J. W. Helps, of Croydon) read the report of the Committee on the past year's work of the Association. The year, the Committee observed, had been an important one, being the first of united work since the amalgamation with the South-West Association; and the unqualified success of each of the meetings justified the conviction that the Association —now the largest "District" Association—had entered upon a fresh and enlarged career of usefulness. The Committee then reviewed the proceedings at the three meetings held during the year, after which they alluded to the satisfactory financial condition of the Association. The receipts, including £80 16s. 5d. brought forward, amounted to £152 4s. 5d.; and the expenditure having been £64 11s. 5d., a balance of £87 13s. remained. The Committee felt that the thanks of the members were due to

Mr. D. H. Helps for the admirable manner in which he carried out the important duties of Hon. Secretary during the term of his brother's presidency.

On the motion of Mr. F. W. Cross (Lea Bridge), seconded by Mr. W. E. Price (Hampton Wick), the report was adopted.

THE EX-PRESIDENT THANKED.

The President said he had great pleasure in proposing a vote of thanks to the ex-President for the very careful and able way in which he had carried out the duties of the chair during the past year.

Mr. Charles Gandon seconded the motion with very much pleasure, more especially as he saw that the Association were again to have the assistance of Mr. Helps in his old capacity.

The motion having been heartily adopted,

Mr. Helps briefly returned thanks.

NEW MEMBERS.

On the proposition of Mr. R. Herring (Dover), seconded by Mr. W. B. Randall (Waltham Cross), Mr. S. Y. Shoubridge, of Sydenham, and Mr. J. C. Belton, of Redhill, were elected members of the Association.

The President then read the following

INAUGURAL ADDRESS.

Gentlemen,—I must first of all thank you again most heartily for having placed me in this proud position. I must confess that, when I first heard my name mentioned in connection with this post, serious misgivings arose in my mind as to my fitness and ability to occupy it with any degree of success—especially so as I have to follow one who has filled the chair with such conspicuous ability and tact. However, having allowed myself to be over-persuaded, I address myself to this great task, resolving to take as my motto "*Nil Desperandum*," and trusting to each individual member to make my work as light as possible, and to be lenient in judgment.

I would commence by stating that I have no new process to bring to your notice, nor the results of any experiments to offer for your criticism; but that I hope to interest you with several experiences that I have met with since being in charge of my present works. My time has so fully been taken up with extensions and improvements to the various departments, that until this year I have had very little time for the prosecution of such experiments.

Seeing that the works under my charge are so little known to any of you, a brief description of them may not be inappropriate. The works are situated on the shores of Torbay, and in one of the most beautiful parts of the bay, about midway between Torquay and Paignton, and close by the Great Western Railway's branch line to Kingswear, from which a siding runs alongside the coal-stores, the floors of which are 10 feet below the rail level. They are three in number, and hold about 4000 tons when full. There are two retort-houses, distinguished as the old and the new; engine and boiler house; scrubbers, 40 feet high and 9 feet diameter; Laycock's washer-scrubber; four 20 feet square purifiers; no less than four holders; and our annual make amounts to 146 million cubic feet. Turning now from this cursory description of the works, and going back to the coal-stores, you will see that we are fortunate in being able to store a large amount of coal under cover; the quantity being about eight weeks' stock, at our maximum consumption of about 75 tons per diem. Situated as we are a long distance from the coalfields, and depending on water carriage, this is by no means too large a stock to have on hand; for on one occasion we were reduced, owing to continuous heavy weather, to within five days' consumption. On the other hand, the storage of this amount of coal is not without its anxieties, owing, of course, to the liability of spontaneous combustion. On one occasion only has this occurred—and this was in the winter after I was placed in charge—though at several times there has been a considerable rise in temperature. The cause of this coal firing was as follows: The cellar in which it was placed had been excavated about 3 feet below the level of the others, and though a pipe had been placed to act as a drain, it had become choked. It thus allowed the water to rise; and the natural result followed. This cellar has since been brought up to the level of the others. I now make it a rule to thrust iron rods into the heaps, which are withdrawn at stated times, and the temperature tested. This, at any rate, is a rough-and-ready means of guarding against undue rise in the temperature, and so enables the manager to avoid one of the most unpleasant experiences that can fall to his lot.

I see it has been suggested that the best way to secure oneself against the evil results of a coal strike or adverse elements would be to store in the open (say) eight weeks' consumption calculated on the maximum daily amount carbonized, which should only be drawn from on an emergency arising. With Newcastle unscreened coal, containing, as it does, a large amount of small, I should be afraid to try this plan. It might answer with screened coal, though I should think that, even then, there would be a very considerable diminution in the results obtainable.

Finding that our carbonizing plant in 1894 was too small for the demands made upon it, we determined to build a new retort-house; and after much consideration, we decided to erect one with a stage-floor. It was commenced in March of the following year, and finished by about the middle of December; and it was furnished with Klönne's regenerative furnaces from drawings supplied by Mr. R. O. Paterson, of Cheltenham. There are six benches, of eight retorts each, 20 feet through, fired on one side only, as usual. The retorts are fitted with self-sealing mouthpieces, with dished steel lids. The ascension, bridge, and dip pipes are 5 inches in diameter; and the hydraulic mains are quarter circle in section, and in separate sections, fitted with combined weir and tar valves (of which more hereafter). There are the usual tar and foul mains. The house is also fitted with West's coal breaking, elevating, and conveying machinery, driven by an "Otto" gas-engine, and drawing and charging machines for manual labour. The total cost of the building, retort-benches, two chimney-stacks, and machinery, worked out to about £80 per mouthpiece. This is rather high; but, of course, seeing the distance we are from the fire-brick and iron centres, and taking into account the fact that we were pressed for time, this sum cannot be considered an unreasonable one. If, however, I had to do the work again, I should proceed on rather different lines. For one thing, I would not have five or six separate contractors to do the work; for though it may be slightly cheaper, it entails no end of anxiety for the Company and their Engineer, besides rendering it difficult to fix blame on any one of them for delays that may occur.

As I have said, we finished the retort-house in the middle of December, and immediately started to work. After we had mastered the method of manipulating the various dampers, we proceeded for some time working very comfortably, and found the benches easy to heat regularly, and very economical in the consumption of coke. This state of affairs lasted for about six months; and then we began to experience the nuisance of stopped ascension-pipes. We tried all sorts of remedial measures—such as lowering the heat, protecting the ascension-pipes from the radiant heat of the benches, placing wet ashes on the mouthpieces—but nothing seemed to afford us any relief. Matters drifted until just before Christmas, when it was no uncommon thing to find whole benches blazing round the mouthpieces.

It was just about the same time that a letter appeared in the

Journal of Gas Lighting asking for help, or rather advice, for one who was in a similar predicament; and though the inquiry did not emanate from me, it might well have done so. The replies, it will no doubt be within your recollection, were many and varied. Among them was one from M. Irminger, of Copenhagen, suggesting the coating of the retort for about 1 or 2 feet inside the mouthpiece with a stiff wash of fire-clay, and adducing his reasons for this procedure. It seemed reasonable; and so I determined to give it a trial on the following day. That night I went to bed with a light heart, thanking M. Irminger for his remedy, and resolving to write to the *Journal* next day giving the result of the experiment. Never a stopped pipe the whole day. But, on going into the retort-house next morning, I found matters just as bad as, if not worse than before; so the letter was never written. Still, something had to be done; so taking advantage of the Sunday stop, we removed the whole of the handhole covers of the hydraulics, to examine the state of things there. They appeared at first sight to be in order; the dip-pipes being sealed in an inch of liquor. Further examination showed there was a lot of thick tar at the bottom. The weir-valves, I should say, were constructed with a screen in front of them, so as to cause the tar to flow away first; ensuring that the dip-pipes should be sealed in liquor only. This is no doubt an excellent theory, and one that would work well with tar of a lighter sort than that obtained from Newcastle coal. I had cause, however, to think that this action did not take place; for though everything appeared right, the benches had been stopped for a period of some four hours before they were opened, and the liquor thus had had time to resume its normal level—an examination the day before by gauge, when working, having shown a seal of from 2 to 2½ inches. The hydraulics were cleaned out and refilled with ammoniacal liquor; and we found a decided improvement in the working next day. As a temporary measure, therefore, I procured a large hose and flushed out the mains every day. This was better; and we managed to go on to the spring, when I resumed working in the old house. I then had all the ascension-pipes taken down to give them a thorough clean out. They presented a sorry sight, some of them having barely a 2-inch hole through them, and the deposit round the pipes so hard that it was only with considerable difficulty we succeeded in clearing them. I also took out the dips and shortened them an inch, so as to ensure working with a lighter seal, and laid on a supply of ammoniacal liquor to each section of the mains, and then started working them again.

All this work, however, has not quite removed the difficulty, for we still suffer to a certain extent. The coal we mostly use is New Pelton unscreened, which contains a large proportion of dead small; and this is no doubt greatly increased by passing through the breaker and other machinery. Therefore, when put in the retort, a large quantity of this dust is carried off with the first rush of gas, and takes the earliest opportunity of depositing itself, along with the heavier tar, on the sides of the ascension-pipes. Working with about the same heats and seals in the old retort-house, we never experienced anything like the trouble. This seems to confirm the view of our late President of the cause of these stoppages—viz., that it is owing to the rapidity with which the charge is put in and the door closed.

While on the subject of this house, there is also another circumstance which may be interesting to you, and that is the change which I have observed takes place in the character of the tar. The gas from the house is taken away by an 18-inch steel foul main, and connected to the 24-inch steel main in the old house, and from thence by an 18-inch cast-iron main to the condensers, which are annular; so that altogether it travels about 400 feet before entering these. Well, some time after commencing to carbonize coal in this new house, we observed that the tar which ran down over the sides of the seal-cups into the trough in front of the condensers commenced to leave a deposit of a very gritty nature, and also that the tar in the trough became coated over with a crust similar to a thin coating of ice on water. From the fact of its being easily melted by steam, it must be a formation of naphthalene mixed with a proportion of extremely fine dust; but it is never observed when we are working in the old house. This is rather a disquieting incident, insomuch that I find the bottom of our new tar-tank is covered with a tough pasty deposit, which chokes up the strainer of the suction pipe belonging to the tar-pump.

Speaking of tar-wells reminds me that we had, in our old one, a practical experience of the unwisdom of allowing the water from the lime purifiers to drain back there. It had been allowed to do so for some time, until an increasing difficulty was reported to me of filling the contractor's tar-tanks, though at the same time tar was constantly being pumped through the scrubbers. This led to an investigation; and on sounding the well, we found it nearly two-thirds full of a thick pasty deposit. How it became so full at first puzzled me, until I happened to notice that the water, which was being pumped from a syphon in connection with the purifiers and allowed to run into a seal cup full of ammoniacal liquor, caused a white precipitate to be thrown down, which, of course, accounted for the difficulty. The well being 20 ft. long, 12 ft. wide, and 12 ft. deep, with only a 2 ft. 6 in. square manhole in the centre, the problem of how to get this deposit out without stopping work in any way became a difficult one. We managed to improvise a dredger by erecting a pair of poles over the manhole, and providing a crab and chain connected to a strong scoop furnished with a projecting point in which a couple of holes were drilled. The *modus operandi* was then as follows: A man stationed at the winch lowered away, while another standing over the manhole furnished with a long pole, which he inserted in the holes already mentioned, pressed the scoop back to the end of the well, and also down into the thick material at the bottom. The man at the winch then reversed his action, and hoisted it up; and after about a week's labour we got everything clear, and our apparatus, if primitive, had the merit of being successful.

Passing on to the purifiers, in which lime only is used, they are worked in rotation; and having had a convenient outlet for spent lime in the sea and the beach, the cost of this method of purification has not proved excessive. Our account under the heading of purification and sundries was working out to about 7·29d. per ton of coal carbonized; and at the same time we have kept down the sulphur to an average of about 10 grains per 100 cubic feet, as reported by the official tester to the Company. Some seven years ago, owing to the numerous complaints we had from people in Torquay and Cockington of the smell arising from the spent lime during certain winds, we were forced to take steps to minimize the nuisance, and for some time always emptied the boxes by night. This answered fairly well during the winter; but in the summer, owing to the inhabitants sleeping with the windows open, we were again requested to take immediate steps for the prevention and cure of this noxious smell. At that time we were prevented from using oxide owing to the want of revivifying space; so we had recourse to drawing air through the spent box for three days and nights, and passing these fumes into a small oxide purifier. We have adhered to this process ever since, having found it work fairly well; though on one occasion, owing to one of the gas-valves leaking and the oxide firing, we had a small explosion in the purifier-house. Now we have to face another complaint—this time from the newly-appointed Devon Sea Fisheries Commission—who object to the deposition of spent lime on the shore, on account of the harm it is said to do the immature fish. But I am glad to say that at last the farmers are coming to our rescue, and are beginning to realize what a valuable manure is, so to speak, at their gates, for there is a considerable demand springing up for it; and I entertain hopes that in the near future we shall be able to sell, instead of giving it away. I have not for many reasons yet tried what the admission of a percentage of air would do to minimize the cost of purification. Judging from the numerous reports of its success in the *Journal of Gas Lighting* and other papers, it seems under certain conditions to give great satisfaction; and I hope to try the process at an early date.

Our storage accommodation in 1894 being about 25 per cent. under our largest output, my Directors consented to build a new holder and tank; and I was accordingly instructed to get out the plans and specifications, and to fix on the site. I determined to build as large a holder as I could between one of our existing ones and the governor-house, and so made the drawings for a tank 114 feet in diameter and 27 feet deep, to contain a three-lift holder, of which two lifts were to be erected at once. The contracts were let; and the excavation was commenced in May. I had had one trial pit sunk adjacent to the site, in order that the contractor might judge the sort of soil and rock he would have to contend with. This indicated that the excavation would be fairly easy; being through a rather soft red sandstone, with occasional thin seams of a stiff clay, and of a slightly harder texture as we reached the full depth. It was found, however, on commencing the excavation, that this guide was a most deceptive one; and for nearly the whole circumference of the pit the excavation was in a sort of bastard slate foundation, or as we call it in Devonshire "shillit." For the most part, it was almost more easily excavated than the sandstone; and only as we reached the bottom was any recourse had to blasting. One of the hardest pieces was adjacent to the existing holder, from which it was only 10 feet distant; and this caused us a good deal of anxiety, as in spite of extra timbering, the embankment surrounding it showed signs of settlement, and the water which drained in on that side was distinctly "gassy." Another hard place was almost immediately opposite this, and was where the inlet and outlet pipes had to come in. The rock here was of an entirely different nature; consisting of a very hard sandstone, which gunpowder would not touch, and we had therefore to use dynamite. The excavation was made in the ordinary way, by digging a trench round the whole circumference 12 feet wide, and closely timbered and strutted throughout. Water did not trouble us very much, as, in spite of unfavourable weather, a couple of 2-inch syphons leading to the beach were sufficient to keep us clear until we came to the bottom, when a small pulsometer was set up.

The excavation being finished, we put a ring of 4-inch drain-pipes round the whole circumference, to lead the water to the sump, and proceeded to put in the concrete foundations and chambers for the inlet and outlet pipes. We then brought up the walls, which were of brick and cement, backed with clay puddle, to the height required. The centre portion was next taken out, and the cone formed, concreted over, and finished with neat cement. On Jan. 1, 1895, the contractor for the iron-work took possession, and commenced the erection of the holder, which was finished by May 30. Water was then run into the tank, which proved to be a sound one, though not absolutely tight. The inlet and outlet pipes (which were of steel 27 inches in diameter, with cast-iron syphons and duckfoot bends) were finished off, and the holder inflated with air for testing and adjusting the carriages. We then sealed the pipes with water, and tested the holder for soundness. This having proved satisfactory, we proceeded to connect the pipes to the inlet and outlet mains.

I was congratulating myself that at last my anxieties were over, when word was brought that the men could not pump the water out of the inlet-pipe. I had the cover removed, and found it half full of water. We therefore attached a steam-pump, which brought the water out after about one hour's work; and I was then lowered down the pipe on the gasholder side, to see what was the cause. I found that the duckfoot bend had cracked right across the bottom, and that the water was rushing in almost as fast as we could pump it away. This was a very serious matter; and at first the only thing to be done appeared to be to empty the tank and take out the bend, which meant at least six or seven weeks' labour, besides running the risk of damaging the tank. As I wanted to let another holder down for repairs, I determined to try and stop the leak in a different way. I first satisfied myself that the incoming water was not from the tank, but from the land springs, on account of the water only rising in the inlet-pipe to a certain height, which was about 10 feet below the level of the water in the tank. I then coupled up the steam-pump to the sump-hole, which fortunately had been left open, and proceeded to pump the water out of that. This reduced the inflow to a very small stream; and a man was able to go down and drill an inch hole in the bend just above the crack. Into this was driven a piece of tapered iron pipe, and then a length screwed on sufficiently long to reach the top. The water in the sump was then allowed to regain its natural level, and we poured down the 1-inch pipe portland cement grouting; feeding it in with a small iron rod. After letting it stand for about twelve hours, we again pumped out the water from the pipe, and found to our relief and satisfaction that everything was tight. To make assurance doubly sure, a ⅜-inch wrought-iron plate was fashioned to the bend, bedded in with red and white lead, and screwed on with set-screws; and we have experienced no trouble with it since. As to the cause of this unfortunate accident, the contractor and myself were at variance—as was probably only to be expected. He held that it was brought about by a settlement of the wall of the tank; but as soundings and levels taken on the curb showed no signs of settlement, and also the rest-stones were perfectly true one with the other, I could not accept this reason. My own opinion is that it was caused by a strain being set up in the bend itself, owing to the shrinkage of the metal in casting.

Turning to the distribution, we have two trunk mains leading into the town of Torquay, from which various branches are taken off *en route*. Torquay is, as many of you know, a very up-and-down sort of a town, and may be said to be built on five hills. The levels range from 13 feet to 448 feet above Ordnance datum; and as the works stand at about 50 feet above the datum line, we have a good range of varying altitudes to supply. The greater part of the town is laid out with villa residences, with usually a large garden attached to them; and though we have about 46 miles of mains, the number of consumers per mile is very low indeed—being according to our last returns only 58. This number will in the present year be increased, owing to the growth of the prepayment system. No effort has hitherto been made to reduce the pressure on the hills—which at some parts of the day is excessive—beyond the laying of small-sized main-pipes; and for many reasons the question of districting is one that will have to be approached with considerable caution. Nearly all the houses have been fitted with very small pipes—¼ inch for the most part—and the moment the pressure falls below 25-10ths, the office is filled with complaints of no gas, bad light, &c. Just as I write a typical case has been brought under my notice. The pressure at the back of the house was 16-10ths, and in the front only 4-10ths; and the moment you explain this to the consumer the answer comes: "Oh, if I have to pull my house to pieces, I may as well put in the electric light." Still, something will have to be done to reduce the unaccounted-for gas, which at present stands at the high figure of 10 per cent., though that this is all leakage is not, I think, the case. Condensation plays an important part, as also the difference in temperature, and last, but not least, the public lighting, which is carried out by the Corporation on the average meter system. However, this year I look forward to trying in a small way the effects of regulating the pressure by means of district governors; and I hope at some future date to lay the results of the experiment before you.

The consumption per consumer, disregarding the amount used for public lighting, is fairly high—working out to 43,000 cubic feet; whereas in 1879 the amount was only 33,000 cubic feet. This, of course, shows that our efforts to increase the consumption by reducing the price of gas, and by the letting out of cooking and heating stoves, have met with a fair share of success. But though one must not grumble at an increase, however obtained, I would far rather have found that the amount per consumer was stationary, and the rise accounted for by a larger number of consumers.

We have now introduced the prepayment system, which promises to rectify this. We have just completed one year's working, during which time we have fixed more than 400 meters; giving the consumers gas at the rate of 20 cubic feet for a penny, and supplying one pendant, one bracket, and a boiling-ring, and, of course, doing all the fitting. This latter is let to a local gas-fitter, at the rate of 16s. 6d. per house; he finding all materials, from the stopcock, excepting the fittings above mentioned. We find that the average cost of fitting up the houses works out to £5 7s. As the excess price is 1s. 2d. per 1000 cubic feet, I hope to show my Directors that this new field for extension is one worth cultivating. The average consumption per house works out at about 9000 cubic feet; but this is probably a low estimate, on account of the larger number of meters having been fixed towards the end of the year. We have had few difficulties in our way. The most general has been the inclination of the meter to let people have too much gas for their money; and though they had signed an agreement to pay for any excess of gas used, it was astonishing to find the number of consumers who said they had never read or understood that condition. This has been rectified now, and the last report is more satisfactory; only three or four having been discovered slow, and these only to a slight degree. We found it much better to pass over these relapses in silence, as, the system being on trial in our neighbourhood, it would not have done us any good to allow the consumers (who, generally speaking, are not slow to let the world know of their fancied wrongs) to air this grievance.

Torquay has, like many other towns, been bitten with the craze for electric lighting; and I hoped to be able to give the meeting some of the results of the enterprise. The Order was obtained about six years ago; but, from one cause and another, no start was made until the beginning of last year. Everything was to have been ready by about the end of September. Owing, however, to the disastrous strike of the engineers, the works are not yet in order; so that I can only give you a few particulars of the machinery employed, and not as to how far it has affected the consumption of gas. The machinery is placed in some stores belonging to the Corporation adjoining the new harbour. It consists of three Babcock and Wilcox boilers, each of 150-horse power, and one Green's economizer. There are three sets of Willans and Robinson's 3-crank compound engines, each working up to about 250 indicated horse power, driving alternators made by Easton and Anderson; three rectifiers for the current supplied to the arc lamps, made by Ferranti, by whom also the switch-board is manufactured; and the usual feed and circulating pumps for the condenser, for which sea water is to be used. About 3½ miles of cable have been laid in the main roads and streets; and the Corporation have erected 57 arc lamps to light the streets. How many gas-lamps are going to be displaced is not yet settled; but there is one instructive fact in connection with these. The price fixed by the Electric Light Committee to be charged for the arc lamps is £25 per annum each—or a total of £1425. The amount the Corporation pay us for the gas supplied to 820 lamps is £1487 per annum; so that in future we may expect the lighting bill for Torquay to be a fairly heavy one. As an example of what can be accomplished by gas, we have had a Denayrouze light fixed outside our offices; and we do not think we shall suffer much from comparison.

In common with many other towns, we are much troubled at times by naphthalene; and I have tried many remedies, all of which have been recommended me as certain cures of this evil, but with no diminution in the number of the complaints. During the past year we certainly have had fewer; but I cannot pretend that this is owing to any new method employed in working, but rather to the fact that the extremes of the night and day temperatures have been very much less than usual. M. Brémond and Mr. Botley have shown us how to free our services from this pest; but we want to go further than this, and find how to keep this hydrocarbon from being thrown down and carried into the tar-well. It is a difficult problem, but at the same time an exceedingly interesting one; and no doubt a rich reward awaits the man who can solve it satisfactorily.

The residuals market, with the exception of tar, appears to be in a decidedly more healthy condition at the present time; and the wish of "Long may it last," will, no doubt, be re-echoed by all here. The mountains of coke that blocked our yards, and the heavy stocks of sulphate, have disappeared. The extended use of water gas will no doubt tend to prevent coke from becoming a drug in the market; while one hopes that the new Association of Sulphate Producers will help us to keep this article at a more regular price, and, by removing the prejudices that exist in the minds of our agriculturists against the use of this valuable fertilizer, extend its use considerably in this country. With regard to tar, matters do not seem quite so hopeful. There is one way by which some of the surplus tar might be used up, and that is by the use of tarred macadam for road making purposes. Our Borough Engineer (Mr. H. A. Garrett, Assoc.M.Inst.C.E.) is now laying some down as an experiment, and so far the results have been very satisfactory.

And now I turn to a very different and complicated matter; but it is one that is forcing itself more and more on the attention of gas companies. I refer to the action of the rating authorities in attempting to raise the rateable value of gas property in a most unfair degree; and though, of course, in the end the consumer has to pay, it is not by any means a proper policy to adopt, especially now, as many of the public bodies are supplying the electric light in opposition to us. I hoped to have collected some statistics on this question, and to have laid them before you to-day; but time has prevented my so doing, and therefore my remarks must be mainly confined to our own experience. My Company have three parishes to deal with; the major portion of the works being situated in Paignton, which is supplied by a separate Company. The minor portion, together with about 7 miles of mains, is in Cockington; and only the offices and mains are in the parish of Tormoham, or Torquay. For many years we have been paying the lion's share to Torquay; and as the other parishes seemed content, and the total rateable value was a fair one, it was not our duty to make a disturbance, and say how it should be apportioned. But at the last quinquennial valuation, all three parishes demanded an increase. Paignton and Cockington we felt were to a certain extent justified in their demands; and, after an interview with the Assistant-Overseers, we settled the matter in an amicable manner. In Tormoham the reverse was the case; and we felt we could no longer yield to their voracious appetite. Accordingly, we consulted an expert in the matter; and after his report had been received, we went before the Guardians, and presented our case. They, in turn, called in another expert to go through our works and accounts; and, after a long delay, his report was presented. The figures were as follows for the Tormoham parish only: Our expert, £875. Guardians' expert, £1950! Guardians' demand, £2900!! After a further period of waiting, and much correspondence, rather than carry the case into Court, the matter was compromised by our accepting the sum of £1750 as the rateable value. Taking the experts' reports, just look at the difference that exists between them. Surely I am right in saying that it should not be possible for any two men to differ so much in fixing the rateable value of any works, especially as they both accepted our valuation of the works, mains, and stocks as being a fair one. Calculating the amount of the tenants' capital seems to me to be the rock on which so much of the dissension is founded; and I, for one, think that it is high time the Legislature stepped in and laid down rules of procedure, by which this rock could be made a surer foundation. We most of us have, at one time or another, had to undergo the hard work and anxiety entailed by these vexatious demands; and I think the gas interest should unite and force this matter on the attention of those who make the laws, until they step in and take this matter up, and so prevent an enormous amount of public money being absolutely wasted.

In concluding this address, there is one other subject on which I should like to say a few words. I have been very much struck with our last President's able pleading for the establishment of a gas-works for the purpose of experimenting and reasoning out the laws which govern the economical production of coal gas; and I cannot help wishing that such a realization of his views were likely to take place, for it would, I fully believe, be of inestimable advantage to the profession to have such a works established. However, his plea, as far as I am aware, has been received with silence. I now, with all deference, venture to make a suggestion; and I do not see any great difficulty to prevent it being carried out. Now there must be a large number of gas-works the managers of which have not the time, means, or apparatus for carrying out any experiments necessary for the proper reasoning out of the phenomena which often occur; and especially is this true when it comes to making analyses. The scheme, therefore, that I venture to offer for your consideration is briefly this: That the Institutes (I hope one day we shall again be able to say the Institute) should appoint a chemist whose duty it would be to test samples of any materials that might be sent to him, and generally to collect and classify data as to the many difficulties and odd circumstances that are continually cropping up in any works. He should also be allowed to travel to any works requiring his assistance or advice. Now, of course, I do not mean that this should be done free of expense to the gas company or authority. A fee according to the distance and time required should be charged, to recoup the Institutes for the outlay; and the information obtained should only be open to members. By this means, I think our leading bodies would be capable of doing a large amount of useful work, and of spreading much important information among the profession. Take, for example, the work just accomplished by a Sub-Committee of the Incorporated Institution of Gas Engineers in their report on a proposed ten-candle standard. Who will deny the importance of this report, and who does not thank the members for having given so much valuable time and thought to carrying out the necessary experiments? The work these gentlemen have done so well should, I say, be carried on by paid assistants, under the direction of the Councils of the Institutes, on the lines sketched above.

Mr. W. D. CHILD (Romford) asked the members to join with him in a cordial vote of thanks to the President for his interesting address. He was sure the members of both the Southern and South-West Associations looked forward to some advantages being derived from the amalgamation of the two organizations; and in securing Mr. Beynon from the South-West Association, the Southern members at all events might feel, with some satisfaction, that good had arisen from the combination of the two bodies. Mr. Beynon had successfully passed through the ordeal that was experienced by all Presidents of Associations in preparing an address—*viz.*, the difficulty of finding new matter to present to the members; and he (Mr. Child) hoped his year of office would be a pleasant and beneficial one.

Mr. NORTON H. HUMPHRYS (Salisbury) asked to be allowed to second this vote of thanks. As the late Secretary of the South-West Association, he might say that in the days of that Association they looked to Mr. Beynon as a very great help in giving them practical information. They had a marked example of the ability with which he could do so in the address which they had heard read. It contained a great deal of useful information, and gave them much to think about. As one who took a prominent part in the proceedings which led up to the amalgamation of the Southern and South-West Associations, he (Mr. Humphrys) was very pleased to hear the expressions that had fallen as to the success of that amalgamation, and to learn that the first year's work under the changed conditions had been such as met with the approval of the Committee.

The motion was carried by acclamation.

A brief acknowledgment by the PRESIDENT closed the business.

The members subsequently dined together.

MIDLAND ASSOCIATION.

ANNUAL MEETING, FEB. 24.

This Meeting was held at the Grand Hotel, Birmingham—the PRESIDENT (Mr. J. T. Lewis, of Wellingborough) in the chair.

The HON. SECRETARY (Mr. C. Meiklejohn, of Rugby) commenced the proceedings by reading the minutes of the meeting held on Oct. 28, 1897; and they were confirmed.

ANNUAL REPORT AND ACCOUNTS.

The annual report and accounts were then presented. The former was mainly devoted to a review of the proceedings at the three meetings held during the year 1897, which were all eminently successful and profitable. It also stated that four new members had joined the Association, one had ceased to be a member under the operation of one of the rules, and five members had resigned. The accounts showed that, with the balance brought from 1896 (£89 11s. 9d.), the receipts amounted to £134 12s. 6d.; and deducting the expenditure, the sum of £87 14s. 4d. remained to be carried forward. The outstanding subscriptions, it was mentioned, amounted to £6 16s.

Mr. W. BELTON (Shrewsbury) moved the adoption of the report and accounts.

Mr. J. S. CRANMER (Stratford-on-Avon) seconded the motion, which was unanimously carried.

NEW MEMBERS.

On the motion of Mr. W. NORTH (Stourbridge), seconded by Mr. J. S. REEVES (Bilston), the following gentlemen were admitted to membership of the Association: Mr. J. R. Heath, of Etruria, Stoke-on-Trent; Mr. F. J. Ward, of Knowle; Mr. W. G. S. Cranmer, of Willenhall; Mr. A. Gould, of Bewdley; and Mr. F. W. Torpey, of the Whitwick and Coalville Gas-Works.

PRESIDENT'S ADDRESS.

The PRESIDENT then proceeded to read his

INAUGURAL ADDRESS.

Gentlemen,—To-day, in occupying the position as your President, my first duty is to most heartily thank you for the honour conferred upon me in electing me to this high position. During the course of one's career, the hope that some time we may be found worthy of occupying the position of President, animates most of us; and if such has been my ambition, the fulfilment is certainly in advance of my desires. If I should fail in thoroughly grasping aright the responsibilities attached to the office of President of an Association having, like this one, a distinguished record of the past to look upon, I must ask you to accord me that kind indulgence and support which I know has been so readily given in the past to my predecessors. So far as lies in my power, no effort shall be wanting on my part to maintain the high status of the Association, and if possible to increase its sphere of usefulness.

The past year has been a memorable one in the annals of our country; for we have celebrated, under the happiest conditions, the record reign of a record Sovereign. May our beloved Queen, and we her loyal subjects, be spared to participate in the seventieth anniversary of her most beneficent rule over this the greatest Empire of the world.

The winter we are passing through is one of extraordinary mildness; such spring-like weather is only remembered by the oldest inhabitant. Our labours have been thereby lightened, but at the expense of a reduced output. Fortunate are those who can report an increased consumption of gas in spite of these adverse conditions.

The past year has, on the whole, been chiefly remarkable for steady growth and prosperity. No startling innovations have taken place in any of our processes. There has been, however, marked evidence in all directions of efforts made to bring plant up to date. Happily, with few exceptions, our works have been free from labour troubles of a serious character; but unfortunately for the welfare of our country, such has not been the experience in other industries. The stupendous struggle at one time threatened by the Railway Men's Union, was only averted by the firm and determined position taken up by the railway companies concerned, who insisted upon the right of dealing with their own men in their own way. In this contention, they were wisely backed up by the President of the Board of Trade. The fearful struggle commenced by the Engineers' Union is now, I rejoice to say, a thing of the past; but though the fight is over, its evil effects are widespread, and will, I fear, be lasting.

We, as responsible heads of large labour employers, are deeply interested in these matters; and we owe a great debt of gratitude to the Employers' Federation for so bravely and determinedly fighting the battle of liberty against the tyranny of New Unionism. As patriotic Englishmen, we claim of all nations the greatest freedom. It is our boast that we have perfect liberty of action in all things consistent with the welfare of the people and the State; and yet it is impossible to conceive a more intolerable form of slavery than that to which so many of our fellow countrymen seem willing to submit, in carrying out the dictates of their various Unions—for it cannot be pretended that the members of a rampant Unionism have that freedom of action which we feel that every individual ought not only to possess, but to exercise. It is a well-known fact that individual members of a Union, however much they may dislike or disapprove of their leaders' action, dare not, except in rare cases, oppose the carrying out of their behests. Not content with securing the bondage of the men, the Unions have for a considerable time exercised in various degrees their power to prevent the employers from obtaining from their men and machinery such returns as they had a right to expect. This spirit of interference on the part of the men's Union representatives had become so unbearable that the employers were driven to assert their right to freedom of management in their own workshops. This intolerable interference with the rights and privileges of the employers has been broken by their Federation, let us hope for ever; and now that this has been done, and the employers have shown their power to protect and preserve their rights, let them take care the power called into existence for defence is not used at any time for offence, but see it is used on the side of true freedom and righteousness.

To maintain true industrial peace, there must be perfect freedom on the part of the employee, as well as on the part of the employer. We all recognize that both have their rights, privileges, and responsibilities. Both have capital to invest, which only differs in kind and quantity; and both are entitled to an adequate return upon their investment. How to secure the right proportion to both parties without strife, is the difficult problem to be solved. It is no new question that has arisen during the last few years; for in some form or another, the history of our industrial life is full of differences between employed and employer.

Is there a true solution for these difficulties at hand? Is profit-sharing, or making our employees shareholders in our respective concerns, the solution? I think it is, and that in the end this will be generally acknowledged and acted upon. I fully admit that the difficulties of applying the principle in practice are great, and that it is only where there is an earnest desire to make profit-sharing a success that it will succeed. It is not a thing to be taken up as a fad, or temporary sop in case of emergency. This idea of profit-sharing is to many minds considered unfair, because profit only is shared; and it is said truly that the losses ought to be shared likewise, if the idea of partnership is properly carried out. But is not profit-sharing, in the shape we know it, more an addition to wages in the form of a lump sum for good service rendered, than perhaps an actual share of profits? As soon as these payments begin, the door is opened for the employees to invest their money in the concern, and ultimately to become true shareholders. With gas companies it is comparatively easy to carry out a scheme of profit-sharing; but with corporations and other local authorities, the case is very different. It is to the lasting honour of Mr. George Livesey that he, at great cost, stuck to his scheme of profit-sharing; and he has shown that, in the case of the South Metropolitan Gas Company, it is an unqualified success. Surely a scheme that has restored good feeling between employed and employers, and that has enabled the employees to become shareholders in the Company by investing the magnificent sum of £100,000 in the capital of it, is one at least worthy of our fullest consideration, and, if circumstances permit, of our imitation.

Putting aside the difficulties of the labour question, we have to face competition from various sources for the supply of light. It matters not from what source the competition comes, it is real, and should stimulate each of us to adopt every means within our power to overcome it. We must not delude ourselves with the idea of fancied security, because to-day we are able to maintain supremacy over our competitors. No; whatever the future may bring, it is clearly our duty to see that our plant is the most efficient possible to manufacture gas cheaply, and of the highest quality consistent with the price to be paid for it.

For a few moments, let us consider the changes that have already taken place in our working results during the past twenty years—results rendered possible not so much by changes in plant and methods, as by improvements in and knowledge of the working of the plant placed at our disposal. When the standard work of the gas profession, "King's Treatise on Coal Gas," was published, no furnaces of the generator or regenerative type were in use in this country; they had been tried, but were given up. In some few instances, they were in use on the

Continent, giving promise of the results since obtained. The fuel account was high; the sales of coke not averaging more than 8 cwt. per ton of coal, instead of 10 cwt. to-day. The make of gas per mouthpiece was from 5000 to 6000 cubic feet; while to-day the average would be between 7000 and 10,000 cubic feet. The yield of gas per ton of coal did not then average more than 10,000 cubic feet; now we are not satisfied with less than 11,000 cubic feet. The actual difference is rather greater than stated; for the reason that at the present time coal contracts are based on a ton of 2240 lbs., while during the earlier period they were almost universally made on 2352 lbs.; and in the case of seaborne coal this weight was exceeded.

Stoking machinery was at that time little known; and machinery in gas-works, beyond the exhauster and pumps, was conspicuous by its absence. Nearly all the work was performed by hand; and certainly it was more arduous, as far as the retort-house portion was concerned, owing to the generally cramped area of the old houses compared with the roomy and well-ventilated ones of the present day. Wages during this period have enormously increased; and yet, owing to the great difference in the working results, and economies effected in distribution, the price of gas is very considerably lower, while I believe that generally speaking the illuminating power and purity are to-day higher than before. If such results have been achieved during the past twenty years, who is prepared to say that the acme of perfection is reached? Certainly I do not think that we have as yet obtained the highest results possible by the carbonization of coal. I look forward to the time when our working results will agree very closely with the best analysis of the coal.

At present I do not think we fully understand the effects of temperature and time-contact in determining the yield of gas and illuminating value upon the coal carbonized. We know that increased heat gives increased yield of gas of a lower illuminating value, but with greater yield of illuminating matter. For instance, a coal yielding 10,821 cubic feet of 16·7-candle gas, equal to 36,140 candles per ton, will at a higher temperature yield 12,006 cubic feet of 15·6-candle gas, equal to 37,460 candles per ton—an increase of 1320 candles. In ordinary working with mixed coals of different qualities, I find that our results average about 11,000 cubic feet of 16·5 candles, or 36,300 candles per ton of coal carbonized. But I have on several occasions obtained from the same coals much higher results when making working tests—as, for instance, 12,256 cubic feet of 16-candle gas, equal to 38,923 candles, and 12,396 cubic feet of 15·75-candle gas, equal to 39,219 candles per ton of coal carbonized, or an average of 39,071 candles, which gives an increase of 2771 candles per ton of coal. The very interesting experiment on the instantaneous production of gas from coal, referred to by Mr. W. Foulis in his Presidential Address to the Institution of Gas Engineers, in May, 1896, is worthy of attention and further experiment; for though the experiments might prove the impracticability of the method for the ordinary purposes of carbonization, I think a good deal of useful information would be obtained on this all-important subject.

Stopped ascension-pipes have an important bearing upon the production of gas. Where this trouble is of frequent occurrence, the loss of gas must be considerable. Many are the so-called cures that have been tried to prevent this difficulty; but the trouble still remains. We used to hear very little about the subject previous to the custom of carbonizing at high temperatures. Like others, I have had my share of these troubles —in fact, at one time it was almost painful to go into the retort-house and see the men at the trying work of clearing out the ascension and bridge pipes. The difficulty always increased when the heats were higher than usual; and then it took a long time to get straight again. I found invariably that the hydraulic main had much to answer for in connection with this matter owing to the dip-pipes being sealed, not in liquor, but in a very soft pitch, so that the gas was prevented from freely getting away. I could not dispense with all the hydraulic mains, so I had to try and remedy the difficulty; and, as far as an extension of the retort-bench is concerned, I have certainly succeeded, if not in curing it, at any rate in reducing it to a minimum. I altered the shape of the hydraulic main from ◡ to quadrant, which considerably facilitated the removal of the tar. In both mains, the gas, tar, and liquor outlets are separate; but special care was taken to see that the tar and liquor outlet arrangements really worked with the new main, as considerable difficulty had been experienced to get the overflow arrangements to always do their duty on the old sections of main. For the last four or five years the stoppages on the new section of main have been very few indeed; and none have been so bad as those experienced with the old sections still in use. To maintain this favourable state of things, the main is examined and flushed out with ammoniacal liquor every day; so that the dip is always sealed in liquor, and the gases have a free passage. A gentleman who has had great experience in the erection of retort-benches of all kinds, tells me that in his experience the difficulty of stopped pipes really begins with the front and top heat of the settings—that is, the quantity of heat escaping from the front and top of the settings really tends to dry up the tar in the hydraulic main, forming pitch. This interferes with the seal; and then the trouble begins. His remedy is not so much increasing the thickness of the front walls or arch of the settings, as to see that there is ample flue and chimney area. The examples cited by him, where enlargement of either main flue or chimney, without any interference of the settings, has caused the stoppages to cease, certainly bears out his contention.

The subject of continuous stoking or carbonization is one that has received a good deal of attention from very early times in the history of gas manufacture. The more recent are the arrangements of Messrs. R. & J. Dempster and Mr. Elliott. It will be in the recollection of many members that Mr. Hack, in October, 1891, read a paper before the Association on Elliott's process of continuous carbonization, in which he gave full particulars of the system and the results obtained at Swan Village with apparatus in practical working. Unfortunately for the inventor, the results did not come up to expectations, owing to trouble in working the process, as well as a great falling off in the yield of gas and reduction of illuminating value.

Messrs. Dempster's arrangements were of a somewhat similar character; and though I, for one, had great hopes of the ultimate success of the process, the inventors, after a long period of experiment, at their own works, gave it up. Their reasons for so doing were that at the time they had begun to perfect the mechanical portion of the plant, the inclined-retort system was coming into use; and it appeared to them that if charging and discharging could be done without machinery, it was useless to put up a plant with a machine to each retort, which in a large house would mean a good deal of wear and tear. There was also the difficulty found by Mr. Hack—viz., stoppages of the main with lampblack, caused by the green gas from the freshly-inserted coal travelling over the coke and getting decomposed—and though the gas was taken off at both ends of the retort, the difficulty did not cease. Taking the average make of gas per ton of coal, the results agreed closely with those obtained at Swan Village—viz., between 8000 and 9000 cubic feet per ton. From the results of these experiments, it seems clear that we cannot expect much assistance from any available system of continuous carbonization, unless the results said to be obtained from the Yeadon retort of 12,500 cubic feet of 20 to 22 candle gas per ton of coal are proved to be correct; and of this there does not appear very much hope. With a view of adopting the best system of carbonization for a considerable increase of producing power, I made many inquiries as to the comparative advantages of the following systems: (*a*) Regenerative settings fitted with coal conveying, charging, and drawing machinery; (*b*) inclined retorts; and (*c*) carburetted water-gas plant.

The results of the inquiries, which were made nearly two years ago, I propose to lay before you, supplemented by more recent information; and as there is always some difficulty in getting information of this, inclusive of the same items, I have thought it best to give you the figures exactly as supplied to me. With regard to the results obtained by the use of manual machinery, I had sufficent experience to enable me to decide as to its merits and the saving effected by its use, as compared with hand labour only. It will be remembered that in October, 1894, I read a paper on "The Use of Charging and Drawing Machinery in Small and Medium-Sized Gas-Works;" and therein I gave figures proving that the saving which had resulted by the use of machinery was from 8½d. to 1s. 6¾d. per ton of coal carbonized. In addition to the saving in wages, I also claimed that the machinery reduced the most arduous work of the stoker, and that a very considerable saving was effected in the time taken to charge and draw the retorts; and, further, that the make of gas was increased per ton and per mouthpiece through the expeditious working and even distribution of the charge. I have often been told of cases where the cost of hand work is very low; but I have never seen figures to prove it possible to come within the range of wages paid for work done by manual machinery by at least 1s. per ton. The saving by power machinery is much greater, but naturally at a much heavier capital cost.

The retort-house we are now fitting up is 88 ft. long, 64 ft. 3 in. wide, by 34 ft. high from the coke-floor to the eaves. In addition to the retort-house, there is a water-tower, which is divided into three floors as follows: Lavatory on the ground floor, dining-room on the first floor, and reading-room on the second floor. The rooms are each 22 ft. by 13 ft. 9 in. by 9 ft. 6 in. high. A large water-tank, containing 18,000 gallons, forms the roof to the tower. The buildings are of brick, with iron and slated roof. The house is being fitted with six settings of eight retorts, 22 in. by 16 in. ⌓ shape, by 10 ft. long on one side only. The cost of the buildings, roof, and tank is £2355. The cost of the retort-arches, settings, retorts, stage-floor, mouthpieces, and all other ironwork, inclusive of West's manual machinery, with coke-waggons, tram-line, coke and coal elevators, conveyors, coke-screens, coal and coke hoppers, everything being carried out in the best possible manner, is £3256, equal to nearly £67 per retort, or £88 per ton of coal estimated to be carbonized per 24 hours. The house will be ultimately extended to contain fourteen settings of eight retorts each, on each side, or fourteen settings of eight through retorts, 20 ft. by 22 in. by 16 in.

Another house recently fitted up contains eight through settings of eight ⌓ retorts, each 22 in. by 16 in. by 20 ft. long; and inclusive of all brick and ironwork for arches, chimney, and settings—such as furnace and firing doors and frames, mouthpieces, ascension, arch, and dip pipes, foul and hydraulic mains, valves, retorts, girders, and stage-floor material—including a complete installation of manual machinery, with coal-breakers, elevators, hoppers, and conveyors, the cost was £7924. This is nearly £62 per mouthpiece; or, as I prefer to have the particulars of cost, £76 per ton of coal carbonized—the 20-feet retorts being estimated to carbonize 6½ cwt. of coal each 4 hrs. 48 min. The house is calculated to produce 1,144,000 cubic feet of gas per diem.

The following particulars give the cost of 22 through settings of eight retorts, each 22 in. by 16 in. by 20 ft., inclusive of the settings, retort-bench fittings, furnace and firing doors and frames, mouthpieces, foul and hydraulic mains, ascension, arch, and dip pipes, valves, retorts, and a complete installation of West's power machinery, consisting of coal-breakers, elevators, conveyors, hoppers, and air-compressors, &c.; the total cost being £13,990. This sum does not include stage-floor, buckstays, tie-rods, and construction of arches and chimneys. The house is capable of producing 3,146,000 cubic feet of gas per diem; the cost per ton of coal carbonized working out at nearly £49. The figures in Table I. [p. 26], relating to the cost of carbonizing with manual machines, speak for themselves.

For the results of work done in labour saving by power machinery, I must refer you to what is being accomplished at East Greenwich. In May, 1894, Mr. Tysoe, the Superintendent of that station, in his paper read before the Institution of Gas Engineers, gave the cost of the work done by the Arrol-Foulis machinery as 9·3d. per ton, to which must be added 3·2d. for the cost of maintenance fuel, and 10 per cent. for interest and depreciation; making a total of 12·5d. per ton of coal carbonized, compared with 26·3d. for hand work. The results obtained at East Greenwich with West's rope-power machines work out at 9d. per ton, or 0·86d. per 1000 cubic feet of gas produced. Forty-eight men with the machinery are working

TABLE I.—*Working Results with Manual Machinery.*

No. of Works.	Description of Work Included in Wages.	Wages per 1000 Cubic Feet of Gas.		Wages per Ton of Coal.		Coal Carbonized per Man.			Gas Made per Ton of Coal.	Weight of Charge.			Duration of Charge.		Wear and Tear of Machinery per Ton.		Remarks.
		s.	d.	s.	d	Tons.	Cwt	Qrs.	Cubic Feet.	Cwt.	qr.	lb.	Hrs.	Min.	s.	d.	
1	Includes drawing and charging machine men, coke and coal men, picking breeze, and keeping ascension pipes clear.	0	1·77	1	6·40	4	3	0	10,400	3	2	6	6	00	0	0·79	Average wear and tear for ten years.
2	Includes drawing and charging machine men, coal and coke men, pipe jumping, and firemen.	0	1·61	1	5·79	3	19	0	11,122	3	0	0	4	48	..		Wear and tear not given.
3	Includes drawing and charging machine men, coal and coke men, pipe-jumpers, firemen, and exhauster men.	0	1·90	1	9·06	..			11,497	..			..		..		Other returns not given.
4	Includes all items and foreman's wages.	0	1·49	1	4·66	..			11,165	2	3	11	4	48	..		
5	..	0	1·80	1	9·80	..			10,934	..			..		..		Other returns not given.

Note.—In three other cases wages only are given. These are respectively 1s. 6½d., 1s. 2d., and 1s. 7·59d. per ton, inclusive of all retort-house items. The wear and tear of machinery averages 0·64d. per ton of coal carbonized.

26 beds of ten through retorts, or 520 mouthpieces, at a daily cost of £13 6s.; whereas before the introduction of the machinery it took 101 men, at a daily cost of £27 1s. 6d., to work 15 beds, or 300 mouthpieces.* Mr. Hack, in his description of the "Labour-Saving Plant at the Saltley Gas-Works," given us in February, 1895, bore witness to the enormous saving effected by the substitution of power machinery for hand labour.

These examples are sufficient evidence as to the cost of carbonization with the aid of either manual or power machinery. I will therefore now give you particulars of the working and cost of inclined retorts. (See Table II., pp. 28-29.)

As a rule, much shorter inclined retorts are used on the Continent than in this country; and in the *Journal of Gas Lighting* for Oct. 12 last, appeared the summary of a report made by a Committee on the sloping-retort system to the German Gas Association. The report, as showing what is being done with this system on the Continent, is a valuable one. When we compare the examples of the inclined system with those of horizontal retorts and machinery, we have to acknowledge that, per foot run of retort, a larger amount of gas is made with the former than with the latter—or, at any rate, that is true with the shorter retorts. With regard to cost for labour, I fail to see where any saving comes in, when compared with the items given for both systems. As far as capital expenditure is concerned, I think on the whole the horizontals cost less per ton of coal carbonized; but in all these comparisons, it is very difficult to be absolutely sure that they are made on all-fours. There is, however, one most important matter that I should require greater information upon before putting up inclined retorts, and that is with regard to the relative make of gas per ton of coal with the two systems. It may only be a strange coincidence, but in every case in which I have been able to get information respecting the make per ton, it is low compared with what I and many others obtain per ton of coal carbonized with horizontals. In this connection, I find the only comparative

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* In a letter which appeared in the *Journal of Gas Lighting* for March 8, 1898, Mr. Tysoe pointed out that Mr. Lewis had omitted to add the charge of 6d. per ton for labour at East Greenwich which he (Mr. Tysoe) had stated was not included in his figures; also that those relating to the working of West's machines at that station were quite wrong. He supplied the following figures, derived from a recent half-year's working: Hand work, 2s. 10d.; Foulis-Arrol machines, 1s. 9·4d.; West's machines, 1s. 7·8d. He stated that these figures comprise all carbonizing charges, and in the case of machinery also include wear and tear and maintenance, and 5 per cent. interest on the cost of the machines. This led to other correspondence.

TABLE II.—*Details of Inclined Retorts.*

No. of Installation.	No. of Settings.	No. of Retorts in Setting.	Length and Size of Retorts.	Particulars of Installation.	Cost.	Size of Retort-House
1	28	7	..	Inclusive of arches, settings, retorts, and the whole of the ironwork and coal-handling machinery.	£24,963	..
2	6	9	15 ft.; 22 in. × 15 in. tapering to 24 in × 15 in.	For royalties, brickwork in benches, arches, and chimneys, inclusive of all ironwork, stage-floor, and coal-handling machinery.	£7,125	87 ft. 6 in. long, 50 ft. wide, 35 ft. high to eaves. Cost, £2180.
3	..	9	17 ft. long, set to angle of 32°.	Inclusive of all brickwork, ironwork, and coal-handling machinery.	Per Retort, from £75 to £95, according to design.	House for single retorts, 50 ft. wide by 35 ft. high; for double beds, 90 ft. wide.
4	..	9 but 8 preferred in future.	15 ft. long, set to angle of 32°.	Inclusive of all arches, retorts, and settings, all ironwork and coal-handling machinery.	£110 per retort.	..
5	6	9	16 ft. long, 18 in. × 15 in. ⌓ section, tapering to 24 in. × 15 in., set to angle of 32°.	Inclusive of all brickwork, ironwork, coal-handling machinery, and royalties.	£5,386	..
6	12	6	20 ft. long, 24 in. × 15 in. ⌓ section.	Inclusive of all brickwork, ironwork, and coal-handling machinery.	£10,000	120 ft. long by 50 ft. wide and 46 ft. 6 in. high.
7	7	6	20 ft. by 24 in. × 15 in.	Inclusive of all brickwork, ironwork, and coal-handling machinery.	£6,500	..
8	4	6	20 ft. by 24 in. × 15 in.	Inclusive of all brickwork, ironwork, and coal-handling machinery. A very cheaply arranged example.	£3,000	..

No. of Installation.	No. of Settings.	No. of Retorts in Setting.	Length and Size of Retorts.	Coal Carbonized per 24 Hours.	Make of Gas per 24 Hours.	Make per ton Cubic Feet.	Illuminating Power.	Fuel Used for Heating.	Cost of Labour per Ton.
1	28	7	..	..	..	..	..	..	..
2	6	9	15 ft.; 22 in. × 15 in. tapering to 24 in. × 15 in.	..	Estimated to produce 800,000 cub. feet; each retort, 14,814 cub. feet.	..	..	..	..
3	..	9	17 ft. long, set to angle of 32°.	1 ton 6 cwt. per retort.	13,260 cubic feet per retort.	10,200	17 candles.	8 p. c.	1s. 9d., inclusive of all labour.
4	..	9 but 8 preferred in future.	15 ft. long, set to angle of 32°.	1 ton in four charges of 5 cwt. This will be improved upon in future settings.	10,000	10,000	16½ candles, enriched by oil gas to 19 candles.	15 p. c.	1s. 10d., for all purposes.
5	6	9	16 ft. long, 18 in. × 15 in. ⌓ section. tapering to 24 in. × 15 in., set to angle of 32°.	1 ton per retort.	9,938 cubic feet per retort.	9,938	15·97 candles.	15 p. c.	1s. 1·85d.
6	12	6	20 ft. long, 24 in. × 15 in. ⌓ section.	100 tons or 1 ton 7 cwt. 3 qr per retort.	1,000,000 cubic feet, or 13,888 c. ft. per retort	10,000	..	..	Under guarantee, 1s. 6½d. per ton. Stokers' work only actually cost this.
7	7	6	20 ft. by 24 in. × 15 in.	60 tons, nearly 1 ton 4 cwt. per retort.	600,000 cubic feet, or 14,285 c. ft. per retort.	10,000	..	..	
8	4	6	20 ft. by 24 in × 15 in.	..	330,000 cubic feet, or 13,750 cubic feet per retort.	..	..	..	..

test recorded by the before-mentioned German Committee of gas experts is the following: "In comparative trials extending over thirteen days, of retorts of the same section, the average make per ton of coal was 10,168 cubic feet of 15·56-candle gas with the horizontals, equal to 31,622 candles, and 9966 cubic feet of 15·34-candle gas with the slopers, equal to 30,687 candles, showing a loss of 935 candles per ton of coal. The make per mouthpiece was, however, greater with the inclined retorts; but scurf formed more quickly in them." The working of the inclined system will doubtless be much improved in the future; and we may expect to see installations largely increased. But whether the system is destined to entirely take the place of horizontal retorts, is a matter of opinion, the proof of which must be left to time—the great prover of all things.

By the introduction of carburetted water-gas plant, we have received a most valuable addition to our resources. Whether it is used for cases of emergency, or as a regular addition to the ordinary gas production, it is alike valuable. I seriously considered the question of putting up one of these plants; but I found, in getting out estimates of the cost of the apparatus and of manufacture, that our maximum production was not sufficient to warrant me going on with the matter. I also discovered that, owing to the extra carriage on oil so far inland, the cost of manufacture was prohibitory in our case. It was necessary to make a considerable addition to our carbonizing plant; and I got out estimates for horizontal settings with manual machinery, and also for a carburetted water-gas plant. The coal-gas plant, which is being erected, is for a production of 408,000 cubic feet per diem, with a retort-house arranged for extension, and for retorts to be placed back to back at some future time. The estimate for this was £6000. The carburetted water-gas plant was for a production of 370,000 cubic feet of gas per diem. It would have cost, with the buildings, plant, relief holder, oil-storage tank, &c., about £5000; and as our maximum make was under 500,000 cubic feet per diem, this would only enable the plant to be used in mid-winter to half its capacity. I had, for this and other reasons before mentioned, to give up the idea. Unless there is a maximum make of 750,000 cubic feet of gas per diem, I cannot see that a carburetted water-gas plant is likely to be an economical substitute for coal gas, except in rare cases. When the production exceeds this quantity of gas, and the carriage of the carburetting material is not excessive, I think carburetted water gas can be economically used in conjunction with coal gas, and that its use will gradually increase. An error often made is that of comparing the 22-candle carburetted gas with coal gas of 16 or 17 candles, as if they were of equal values. It is difficult to strictly compare values of the two gases on the basis even of candle power. With a water-gas plant, the gas manager is enabled to get a much larger yield of gas from the coal carbonized than otherwise, owing to the ease with which the illuminating power of the mixture is kept up; and in making any comparisons between the two systems, this point should receive consideration.

Another system of carbonization has come before us of late years, due to the improved methods of coking coal. My predecessor, in his Inaugural Address last year, alluded to the experiment being tried at Halifax, Nova Scotia; and Mr. Hunt in his able paper read before the Institution of Gas Engineers in May, 1895, entitled "Notes on Residuals," gave an account of the coking-ovens at the Brymbo Works, Wrexham. I was in hopes of being able to supply you with further particulars of the Nova Scotia experiment, but regret news has not come to hand soon enough. Seeing the great possibilities of these processes, as allies to our systems of carbonization, they should be closely watched. I know that Mr. Darby, of the Brymbo Company, has considerable belief in the possibilities of these ovens for illuminating gas purposes; and I think it very possible that, if the ovens and their fittings were designed by the coke expert and the gas engineer in combination, this belief would be fulfilled.

The great improvements that have been made in burners and lighting appliances during the past few years, whereby the illuminating value obtained from a cubic foot of gas is increased to about 18 candles, is having a remarkable effect upon the use and consumption of gas for lighting purposes; and, paradoxical as it may appear, the use of incandescent burners has, on the one hand, rendered the necessity of keeping up the illuminating value of gas almost an absurdity, while, on the other, any reduction is prohibited. This strange condition of things is brought about entirely through the use of bunsen burners and mantles of incandescing material, in which gas is only required to heat the material up to a high state of incandescence, and therefore gas of comparatively low illuminating value is suitable. But the very use of burners like the Welsbach and the Denayrouze, giving illuminating values of from 13 to 18 candles per foot of gas, appears to me to put upon us a duty of giving gas of the highest possible value for use in the ordinary burners. Otherwise the comparison of light given is very much to the disadvantage of the ordinary gas supplied; for we must bear in mind that, though incandescent burners are very largely used, they only represent a small minority of the total number.

I certainly do not favour the advocacy of a reduced value of the gas supplied from 3·2 candles per cubic foot, but would rather see an increase in this direction. The cry is for cheap gas on the part of some; but with others it is for more light. I am not prepared to acknowledge that to furnish a lower quality gas would necessarily mean cheapening the supply.

The question of lighting and ventilation is one of very great importance. Anything that can be done to reduce the vitiation of the air in rooms where gas is used, would certainly be for the public good. I have a great deal of sympathy for those whose duty it is to carry on their occupations day by day in rooms where an illuminant like gas is used with little or no ventilation. We need not wonder at the depressed feelings and bad heads on the part of those so employed, when we see the conditions under which their work is done. The question of efficient ventilation is a difficult one at any time; but it is rendered much more so by the conditions under which labour is carried on in many factories and workshops. If lighting and ventilation were to be always considered by architects in designing buildings, the question would present a different aspect; but unfortunately they are so tied down—generally speaking, on the score of expense—that with the exception of the better-class buildings little or nothing is done to remedy what architects, as well as ourselves, admit to be a serious matter. It is in the ordinary dwelling-house and factory that the want of provision for taking off the vitiated air and bringing in a fresh supply, is most keenly felt; but for this absolutely no provision is made. The condition of things is very often bad enough during hours of daylight; but when artificial illumination is used, the atmosphere becomes almost unbearable. We, as suppliers of the more generally used artificial light, have to bear much of the blame, without the means of remedying the matter. We can only do our part by giving advice, and supplying gas and burners of the best quality; and in this direction I think those of us who carry on a fitting business have great advantages over those who do not. The medical profession often condemn the use of gas stoves and fires in living-rooms and in bedrooms, on the ground that they are unhealthy. The only reason for this may be prejudice in some cases, but more often it is because due care has not been taken to properly connect these to the flue of the chimney, and to see, when so connected, that the products of combustion are being properly carried away. As there is generally a difficulty about fresh air coming into the rooms, it is much better where possible to bring a fresh-air inlet-flue from the exterior of the building to some position near the stove or fire. Mr. W. Sugg shows this, and other excellent ventilating arrangements, in one of his books, which are worthy of close attention.

Our friend and rival the electric light continues to make headway; and yet in spite of it gas is showing year by year largely increased consumption. We have several private installations; and in each instance a gas-engine is used as the motive power. What is most pleasing to me is that in every case the gas consumption has increased since the change was made. There are undoubtedly cases in which electricity can be used to much advantage, though at a greater annual cost than if gas was employed. A few weeks ago there appeared in all our local papers an extract from the "Local Government Journal," which gave an account of what is termed the "first electrically-lighted village." The extract is as follows:—

> To the enterprising Parish Council of Treeton, in South Yorkshire, belongs the honour of being the first to establish a system of electric lighting. For a capital outlay of £750, they have provided for the lighting of the whole village by means of powerful arc lamps, one of which is of 3000-candle power. The electrical energy is obtained from the Rother Vale Colliery Company; and it is said that the annual expenses, including the sum required for the repayment of the loan, will be less than if any other means of lighting had been adopted. Parish Councils are not empowered by the Legislature to make their electricity; but they can provide all the apparatus for the actual lighting, and there are doubtless many rural parishes near to large towns or to works where electricity is employed, whose councils may be expected to copy the example of Treeton.

The plant provided for the sum of £750 is as follows: One Brush series dynamo, for direct current, capable of carrying 26 2000-candle power arc lamps in series; output 12,500 watts. Twenty Compton-Pochin arc lamps of 2000-candle power, with wired globes, arc posts, insulators, cables, &c., with automatic cut-outs specially strong for street lighting. The arc lamp-posts are of creosoted pine, 25 feet long, and standing 20 feet out of the ground. Brackets carrying the lamps are arranged to swing out for re-carboning. There are 3½ miles of $\frac{7}{16}$ inch best quality copper cable, highly insulated with vulcanized rubber. The loan of £750 has been granted by the Public Works Loan Department, over a period of ten years, with interest at 2¾ per cent. secured on the rates of the parish.

The supply of electricity, power, as well as all repairs and maintenance of lamps, is undertaken by the Rother Vale Colliery Company for £100 a year, which, with the before-named interest and sinking fund means an outlay of £200 per annum. Treeton is a straggling village, with a population of some 2000; the number of houses being about 300. The colliery owners who supply the power would have preferred gas if it could have been arranged; but as the capital outlay would have been some £3000 on a gas-works for the purpose of lighting the village, inclusive of private lighting, the Authorities could not go to that expense. As no one came forward to form a company, electricity was adopted.

If gas had been available for use in the parish, the capital outlay for 60 gas-lamps, as compared with 20 arc lamps, would have been, for columns, lanterns, incandescent burners, and all fittings, about £195; and the annual cost of lighting, cleaning, and repairs would not have exceeded £75, with gas at 4s. per 1000 cubic feet, on the average meter system. Taking the period of ten years over which the loan extends, the outlay for electricity will be £2000; and the estimated cost of gas plant and gas for the same period would have been £945, or a saving to the rates of £1055 over the ten years. The lighting, I am informed, is very good and perfectly satisfactory; but I am of opinion that 60 lamps of even much less illuminating value would be preferable to 20 lamps at three times the distance apart. I have alluded to this example somewhat at length. because I believe it is the best of its kind; and it certainly behoves us to know what is being done by any of our competitors, Of course, the scheme could not have been carried out if a firm like the Rother Vale Company had not been at hand to provide power and electricity; and for this reason it is doubtful whether the example can be largely followed in other small places.

My other reason for speaking of this matter is to say a few words on the position of gas companies in small and straggling places similar to Treeton, who, to my own knowledge, find it extremely difficult to keep their works in an efficient state of order and pay a small dividend to the shareholders. I have no hesitation in saying that many of these companies are badly managed —not necessarily always on the part of the directors or of their manager, but often through circumstances they find it difficult to control. The great drawback to the success of these small companies is the limited business done and the want of greater skill in management. We all know that the directors of such small concerns are not in a position to pay for the skill and knowledge required in managing even a country gas-works.

There are, however, two ways by which they may improve their position and future prospects. The first is that when two, three, or four of these small works are in reasonably close proximity to each other, they should amalgamate and form one company, and sell their old property and erect new and central works, with railway siding accommodation, for the supply of the united district. Wherever this plan has been followed, excellent results have accrued. In one instance in which I was instrumental in getting two companies to combine and erect works on modern lines, the improved results were immediately felt; the price of gas being reduced very considerably and dividends doubled. Where it is not possible to carry out the foregoing plan, there is no reason why several of these small companies should not combine to form one board of management for the whole of their works. In this way, they could engage a general manager and secretary who could advise them as to alterations or extensions required, and who would take the responsibility of keeping the results obtained in their respective works to a much higher standard than that obtained in the majority of small works at the present day. To companies of this kind, who find difficulty in keeping things going in a progressive manner, I have great confidence in recommending this idea; for I am quite certain that in many cases the active competition of other illuminants will, if nothing is done to remedy the present condition of things, keep them in a state bordering on bankruptcy.

Some of you will remember that at our meeting in November, 1890, I read a paper on "Weekly and Monthly Payments for Gas," with the idea of popularizing the use of gas among small consumers. I then gave you some particulars of our experiments in that direction so far as they had gone, and promised to let you know the future results of the experiments; and I have pleasure in now fulfilling this promise. The time that has elapsed since the paper was read has certainly been long enough to test the ideas then advanced. The results have been fatal to weekly payments. At first we met with considerable success; and as long as most of the weekly customers were in one district, the cost of collection was not excessive for the business done. But after a year or two customers moved (some of them rapidly, and by moonlight), until the end was that only a few were left, which caused the system to be of no real value; and as prepayment meters were in popular favour, we put the remainder of the weekly customers on this system, and ended what was an interesting but unprofitable experiment.

The monthly collections have had an opposite result—in fact we consider the experiment has turned out a splendid success. When this system was started in 1888, the idea was simply to obviate the necessity of deposits from uncertain customers, and to reduce bad debts from the class of consumer from whom we considered deposits to be necessary. The plan met with so much favour that, in 1890, when opening up a new district, we determined that we would start with monthly collections. The results were so favourable that in February, 1894, my colleague Mr. Kimbell, the Secretary of the Company, was very anxious to extend the system to all new customers; and as the Directors had proof placed before them of the advantages derived from the plan up to that date, they consented to this being carried out. So successful have been the results that, on Dec. 31 last, out of 1795 customers, 700 were on the monthly system; and from our experience of the rapid increase during the past four years, it will certainly not be many years before it becomes the only method in use, and quarterly accounts will be with us a thing of the past.

The district previously referred to as being opened up in 1890, is supplied by a separate main direct from the works. The gas, on leaving the works, is registered through a station meter; and as the meters in this district are all taken each month, we are able month by month to check the unaccounted-for gas. This arrangement has been of great service to us, as it enables us to keep the leakage down to 4·8 per cent. on an annual consumption of just over 4 million cubic feet, spread over nearly seven miles of main. During the 7½ years this district has been supplied with gas, the total sale, to Dec. 31 last, was 19,734,700 cubic feet, of the value of £3734 5s. The total number of bad debts has been three, amounting to £9 2s. 9½d.; and as two of these were caused by the failures of shoe manufacturers, whose share of the debt made was £8 18s. 2d. for only one month's supply of gas, this is sufficient proof of the advantages of the system in reducing the risk and amount of bad debts.

Of course, these frequent inspections and collections cannot be carried out without involving additional work and expense; but the increase is not so great as it may at first sight appear. Our plan of working the system is to send out an inspector, who not only inspects the meter, but makes out the account in a specially prepared book, and in most cases collects the money at the same time. We find this arrangement to work well; only, as a matter of precaution, the inspector should not continuously take the same district, but should alternate months change districts with another inspector. The work at the office in entering up the books, although increased in bulk, is of a simpler character than with the quarterly system. The advantages fully compensate for any increased labour and expense involved; while the frequent inspection of the meters keeps us more in touch with our customers, and dissatisfaction is reduced to almost vanishing-point. The advantage accruing from the monthly collections of large sums of money are too apparent to need any enlarging upon.

One word of advice to any who may feel inclined to give the system a trial—and that is make the change gradually. I was instrumental a few years since in inducing a board of directors to adopt the plan for their uncertain customers. A year or more ago, owing to a number of serious losses caused by failure of certain firms, the directors decided, against my advice, to make the change throughout their district of supply from quarterly to monthly accounts. The result has been disastrous, as the staff were not able to cope with the work, and the accounts got terribly into arrear; so that customers did not know when to expect their statements. In this case, the inspector took the meters only. The accounts were afterwards made out and collected by the collector—a plan involving more work, and not, in my opinion, so good as that adopted by ourselves.

It is a matter for congratulation that at last steps have been taken to secure due recognition of the merits of sulphate of ammonia as a manure. The Sulphate of Ammonia Makers' Committee, by offering prizes through the various Agricultural Societies in Great Britain, are taking a step in the right direction. I am convinced that the only true way of getting farmers and agriculturists generally to fully recognize the real value of sulphate, is to prove to them, by example, the effect of using it on various crops. Seeing the exhibits, which are sure to be the outcome of the prizes offered by the Committee for competition to the users of sulphate, when visiting the annual show of their county or their District Society, is the best means of convincing them that the apparently high-priced manure is after all cheaper in the end than most of the lower-priced ones that are put on the market with high-sounding names. I have frequently been in conversation with farmers in our own district; and it is astonishing what a lack of knowledge there is on the subject of the properties of sulphate, and its relative value compared with other manures. Especially is this the case when comparing nitrate of soda with sulphate. I have been told over and over again that a ton of sulphate was only equal to a ton of nitrate of soda; and if the results of the competitions now instituted do nothing else than prove that the unit of nitrogen in sulphate is equal to the unit in nitrate, a great work will have been accomplished. I do not know why the Committee are not offering prizes this year for grain crops as well as for roots; but I certainly hope that another season they will be able to make adequate arrangements for competitions to take place in the growth of grain and hay crops. There is another way by which I think much good work may be done, and that is by offering, under suitable conditions to properly qualified farmers, free grants of sulphate for experimental work on hay, roots, or grain crops; those having such grants undertaking to keep a careful and true record of the results of their experiment, as compared with their other crops not so manured.

I trust one of the intentions of the Committee is to have sulphate in evidence at the various agricultural and horticultural shows throughout the kingdom. When visiting the Exhibition in Brussels last year, I was struck with the exhibit of nitrate of soda by a Belgian firm acting on behalf of a German nitrate company; and yet in my several visits to the Exhibition, I could not discover any trace of an exhibit of sulphate of ammonia. I think our product needs pushing with the same energy as has been displayed with nitrate of soda. The Dalmeny experiments recently published are of great interest and value, and prove conclusively the value of sulphate for those particular crops.

The Essex County Council have recently carried out some interesting and instructive experiments on the comparative value of manures, under the direction of Mr. T. S. Dymond, F.I.C. The experiments in which sulphate was used were confined to permanent pasture. They were three in number; both sulphate and nitrate being used, but on separate plots. It was found that both manures increased the hay considerably; sulphate giving the best results. It was also proved that both manures injured the quality of the herbage by diminishing the proportion of clover in it.

These experiments have received striking confirmation from a gentleman who buys large quantities of sulphate from us. Last season, when sowing the sulphate for a crop of barley, he left a narrow strip right across the field unmanured, for the purpose of testing the manure. The difference between the strip and the remainder of the field was most noticeable up to the time of cutting the crop. At this time, the manured portion was fully 8 inches higher than the strip. But after the crop had been carted, it was found the unmanured strip gave promise of a splendid crop of clover seeds (grass and clover seeds having been sown to follow the barley); while the manured portion of the field was almost destitute of clover, but strong with grass. The seeds show the same results to-day as last autumn; giving evidence that clovers require little if any nitrogenous manure. On the same farm, the results last season from sulphate were excellent. Fully one quarter more barley of fine quality, with much greater yield of straw, was obtained per acre over other portions of the farms where sulphate was not used. We sell all our make of sulphate locally; the farmer alluded to in the above experiment really acting as our agent. We find this a much better and more economical plan than selling to farmers direct.

In conclusion, I wish to say a few words about the future of the Association. I, as your President, can do very little; the success of the next twelve months depends entirely upon the support given by the members generally. We are fortunate in having our centre in a district and among gentlemen who are ready almost at all times to throw open their works or manufactories to us; and in the past we have derived great advantages from the liberality and hospitality that have been showered upon us. This condition of things is pleasant to us all; but I cannot help feeling that it also presents elements of danger, for we are tempted somewhat to neglect the more solid work of the Association. I would therefore ask every member to be prepared to take his share of the work by preparing papers for reading at our future meetings. Nothing does more to add to the life and vitality of an Association like this than papers evoking good discussions; and though I do not expect our friend Mr. Meiklejohn to have an offer of a paper from each of you during my term of office, I do hope that he will have so many that for a long time to come it will not be necessary to beg for others. From experience, I can say that great benefits are derived from the writing of papers. I should like to add that I am very greatly indebted to those gentlemen who so kindly gave me information for the preparation of the tables I have had the pleasure of laying before you.

At the close of the address,

Mr. JOHN YOUNG (Norwich) said he was certain he was only expressing the feeling of every member present when he assured the President that it had been with the greatest pleasure and benefit that they had listened to his admirable address. The President had once more forcibly brought before them the axiom that it was in the retort-house that their money was made; and he (Mr. Young) was sure the manner in which he had treated the retort-house in the address was exceedingly good. With reference to the President's plan of collecting gas accounts, it might interest him to know that the monthly payment system was the rule, he believed, throughout the United States; and he understood it had been found very successful there. He moved that a hearty vote of thanks be passed to the President.

Mr. Charles Hunt (Birmingham), in seconding, said he had listened to the President's eminently practical address with considerable interest. It bristled with points; and there was hardly one in which Mr. Lewis's practical mind had not shown itself. He (Mr. Hunt) was particularly struck with his suggestion as to the supply of gas to small villages. The same idea was put forward by him (Mr. Hunt) some years ago, during a discussion on water supply; and he had noticed that within the past few years it had been somewhat extensively taken up, and was approved of by the Local Government Board. If the same course were adopted in regard to the supply of gas, he felt convinced that the same satisfactory result would follow. It was true that "union is strength." There was, however, as they knew, such a thing as too much concentration; but the limit was not by any means reached when these small undertakings became grouped together in a more powerful one.

The motion was carried by acclamation.

The President thanked the members very sincerely for the exceedingly kind way in which they had received his address. If, he said, it had been of any benefit to them, he was amply repaid for the labour involved in its preparation.

Mr. Thomas Glover (West Bromwich) then read the following paper:—

ACETYLENE GAS: ITS GENERATION AND USE.

The Committee of your Association, at their last meeting, having decided that it was desirable to have a paper on the subject of acetylene gas, I consented, at the request of my colleagues, to contribute such a paper; on the understanding that brevity would not be a disadvantage, so long as it led to a discussion afterwards.

It is not too much to say that the subject of the commercial production of carbide of calcium and acetylene gas, as introduced to the British public by that prince of demonstrators Professor Lewes, created quite a sensation of curiosity and expectation three years ago; * and the interest in it does not appear

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* See *Journal of Gas Lighting*, Vol. LXV., p. 168.

to show much indication of subsiding, as the patent columns of the technical press testify week by week. The manufacture on a large scale of carbide of calcium, from which acetylene gas is made, is entirely due to the recent developments in electrical science, which have made it possible, by means of the electrical furnace, to obtain higher temperatures than were hitherto known. The fusion of calcium with carbon can only be effected at extremely high temperatures (approximately 3000° to 4000° Fahr.); and it was while employing such a temperature in an electrical furnace that Mr. T. L. Willson, an American scientist, accidentally produced a hard grey slag, which, on analysis, proved to be pure carbide of calcium. The gas evolved when the slag was dropped into water was acetylene. Some time before this discovery was made, the attention of gas engineers had been directed by Professor Lewes to the important part played by acetylene in the ordinary gas-flame;[*] and his clear exposition as to how acetylene was formed, and to what chemical and physical changes luminosity in a gas-flame was due, had no doubt won for his theory many adherents, and served the purpose of drawing public attention more especially to this constituent of coal gas, which previously had been little thought about except by a few experimenters who had attempted its synthetic production, by various means, with only limited success.

[The author here, by the aid of a drawing prepared from an illustration of an electrical furnace given in the *Journal of Gas Lighting* for Jan. 15, 1895 (p. 120), described the process of making calcium carbide.]

Carbide thus produced consists of 40 parts by weight of calcium and 24 of carbon (formula CaC_2); and the chemical change which follows when water is added to it may be represented by this equation—

$$CaC_2 + H_2O = CaO + C_2H_2$$

By the method of manufacture just described, tons of carbide can be produced now with as little trouble as grains were made before. At the present time, about 800 tons of carbide is the annual output in Britain alone; and there are large manufactories on the Continent and in America. Two years ago this production was *nil*. One pound of commercial carbide will produce 5 cubic feet of gas, the estimated illuminating power of which is 240 candles; so that the British production is equal to about 9 million cubic feet of acetylene, or 430 million candle-hours. These figures show that the industry has assumed a position of importance within a short time; and the question which will be uppermost in many minds here will be how far acetylene is likely to compete with the article we make.

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[*] See *Journal of Gas Lighting*, Vol. LIX, p. 795.

To make a comparison, it is necessary to find at what price carbide can be sold to consumers, and what is the candle power which can be obtained from a given weight of carbide under ordinary conditions. For small parcels, £32 per ton has been paid; but it is now possible to obtain large quantities at about £16 per ton. At the latter price, there must be a fair margin of profit made, or the wear and tear of machinery and plant is heavy. The following is the approximate cost of material and labour for producing a ton (2240 lbs.) of carbide:—

1·8 tons of a mixture of 40 per cent. of carbon and 60 per cent. of lime, at 15s. 7d. per ton	£1	8	0
1804 B. T. units of electricity, at 1d.	7	10	4
Labour	0	10	0
Total cost of labour, material, and power . .	£9	8	4*

The power of acetylene is generally quoted as 240 candles for 5 cubic feet, or 48 candles per foot. This, however, is arrived at by calculation from a smaller consumption; and it is not realized in practice, for the reason that no burner has been found, as far as the writer is aware, which will consume 5 feet of undiluted gas without emitting dense volumes of smoke. From experiments which he has made, he has come to the conclusion that 35 candles per foot of the gas is a fairer estimate. This result was arrived at after using several burners of different construction and size.

Description of Burner.	Gas Consumed per Hour. Cubic Feet.	Corrected Illuminating Power. Candles.	Candle Power. per Cubic Foot.
Bray's No. 0000	1·15	39·55	34·39
Holliday's No. 1	0·55	19·74	35·49
,, No. ½	0·70	22·38	31·02
,, No. ¼	0·46	11·50	23·00

The following figures give the comparative cost in pence of 1000 candle-hours' lighting with the three illuminants named:—

Acetylene Gas.	Pence.
Carbide at £12 per ton	7·35
,, 14 ,, ...	8·57
,, 16 ,, ...	9·79
,, 18 ,, ...	11·02
,, 20 ,, ...	12·24

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* In connection with these figures, Mr. Glover remarked that he had assumed that the electricity was generated at a place where the power could be obtained at a low cost.

Coal Gas (16-Candle) at 2s. 6d. per 1000 Cubic Feet.

	Pence.
Flat-flame burner, developing 3 candles per cubic foot	9·99
Argand do., developing 3·2 candles do.	9·36
Welsbach incandescent do., developing 10 candles do.	3·00

Electricity at 6d. per Unit.

Glow lamp (16-candle), consuming 60 watts per hour.	22·50

For the purpose of the above comparison, it is assumed that the acetylene gas would be produced on the premises where it was to be consumed, and that 11,200 cubic feet would be made per ton of carbide. The figures only cover the net cost of the carbide, without any credit allowance for residual lime. It will be observed that, when carbide is £20 per ton, the cost of acetylene is equal to coal gas at about 10s. per 1000 cubic feet when the latter is used with an incandescent mantle.

It has never been proposed, as far as the writer is aware, to distribute acetylene gas from central works, in the same way that coal gas is distributed; nor is it likely that this will ever be done, as any loss by leakage would add very much to the price which would have to be charged. There would also be many disadvantages attending its use, as compared with coal gas, seeing that the latter is becoming every day of more importance as a convenient fuel. Acetylene can be applied for heating, and for driving gas-engines; but for these purposes it would be about three times as costly as coal gas.

Coming now to a description of the generating apparatus, fig. 1 shows a section of one of Messrs. Read Holliday and Sons' Type "D" machines. A is the generator, in which carbide is suspended in a cage, and subjected to the action of water. B is a valve with a hollow plug connecting the bottom of the generator with the vessel C. A pipe, with a back-pressure valve, also connects A to C, to take any excess gas formed when the taps connected to the generator are all closed. The top of the generator is connected to a cooling-worm D, which surrounds the upper vessel E, but is separated from it by an annular casing; the outlet of the worm being at the governor F. The upper and lower vessels C and E are connected by a tube, reaching to about two-thirds the depth of C. The valve at the bottom of C is used for flushing out any fine sediment that may be deposited.

Gas making is commenced by charging the cage with carbide—placing it in the generator; and when the cap is tightly screwed on, the valve B is opened, and gas is at once made ready for use as required. If the demand for gas is less than the quantity being generated, the back-pressure forces the water from contact with the carbide into the vessel C until, by the pressure on A becoming less, the water again flows, and the production of gas is continued. In this type of apparatus, where a small

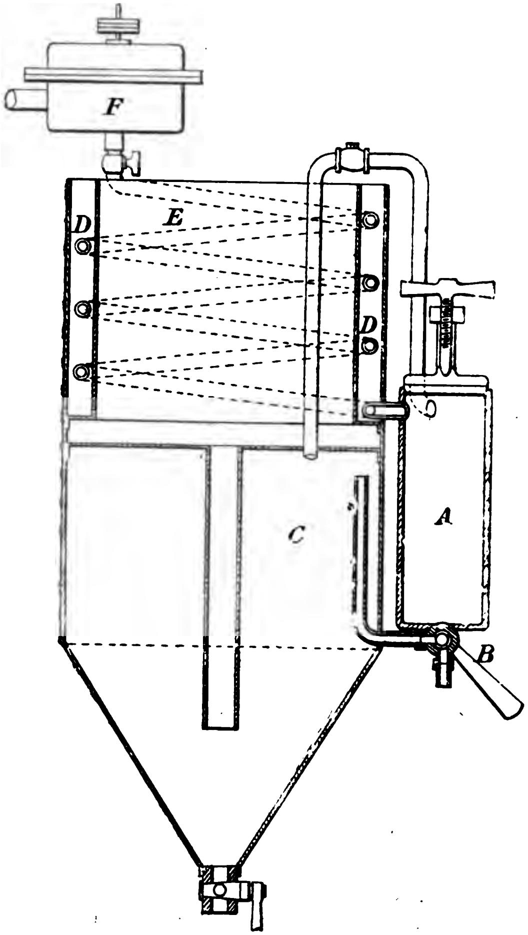

FIG. I.—SECTION OF AN ACETYLENE GAS GENERATOR.

quantity of water is brought into contact with a comparatively large quantity of carbide, there is a considerable rise of temperature in the generator; hence the importance of having a sufficient cooling surface to prevent water vapour being carried forward, which, on being condensed in the consumers' pipes, would give trouble. The gas thus produced may be burnt through ordinary gas-fittings; but special burners are required for its use, since, by reason of its extreme richness, the orifices of burners of the union-jet type must be extremely small, and these have a tendency to stop after burning 100 hours or so.

Fig. 2 shows a section of a burner which has been specially designed to overcome this difficulty, by arranging steatite hoods at an angle on the top of the burner, and over the gas orifices; the hoods being open to admit air at the base. The flame is produced in the same manner as in the union-jet burner, by impinging jets; but the gas orifices are not in contact with the flame, and are not therefore liable to get choked with carbon.

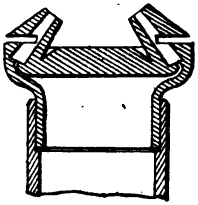

FIG. 2.
ACETYLENE
GAS BURNER.

Purification of the gas is unnecessary, if ordinary care is exercised in the choice of coke and lime at the carbide factory. Acetylene gas has a strong smell; it is colourless, soluble in about its own volume of water, and has a density of 0·92. The quality of the light emitted is almost equivalent to sunlight, and is in this respect superior to any other known form of artificial light. It is therefore specially valuable for judging colours, and for photographic purposes. Owing to the small amount of gas required to be burnt for a given illumination, the vitiation of air is less than with ordinary gaslight. The temperature of the flame is also in its favour; being only 900° Fahr., as against 1400° for coal gas. These are some of the considerations favourable to acetylene gas, which show that it is well adapted for many special purposes; and if the Welsbach burner and mantle had not been introduced for use with ordinary coal gas, and such excellent results obtained therefrom, it is possible that acetylene might have become a much more serious rival than it is likely to be now.

Having dismissed from our minds any undue fears as to competition, we may calmly consider for what purposes, and under what conditions, acetylene can be applied. It has been very properly suggested that for isolated buildings—such as wayside railway stations and country mansions, where a public supply of coal gas is unobtainable—the light will be specially applicable. It possesses many of the conveniences of coal gas, without the disadvantages which attend its manufacture on a small scale; and as compared with private installations of electric light, there would be no delicate machinery requiring attention. The operations connected with producing the gas from the carbide are so simple that it is easy to believe that an installation for a country mansion or hotel could be worked by an intelligent gardener or other servant; and the advantages of such an installation would be great as compared with oil-lamps. For the lighthouses, lightships, and buoys round our coasts, it is difficult to imagine any light which would equal that obtained from acetylene gas.

The unfortunate accidents from explosion which have occurred when the gas was put under compression, have compelled the authorities to place severe restrictions upon its use when compressed; otherwise its adoption for some of the above purposes would have made much more progress than is the case at present. Danger of explosion when the gas is under compression may be minimized by dilution with other gases, and probably coal gas may be used for this purpose. Though acetylene has not proved a cheap enricher of coal gas on a large scale, where one or two candles of enrichment only were required, the latter forms an excellent diluent for acetylene, as it enables the gas to be burnt under better conditions for developing its illuminating power than when used alone.

If time had permitted in the preparation of this paper, an interesting set of experiments might have been made to show the value of acetylene with various percentages of coal gas, and the cost of producing (say) 1000 candle-hours with such mixtures. Perhaps another member of the Association will take this up, and give at a future meeting the results of his investigations.

Apart from its value as an illuminant, acetylene does not appear to be of much commercial value at present, though it may be known to you that other valuable hydrocarbons can be readily produced from it—such as benzol, ethylene, &c. But whether it will ever pay to manufacture these or other products usually made from coal tar, remains to be proved.

[During the reading of the paper, the room was illuminated by means of four burners supplied with acetylene gas from one of Messrs. Read Holliday and Sons' generators, the action of which was examined with interest by several of the members at the close of the meeting. At the conclusion of the paper, Mr. Glover, in order to show how readily gas was given off by calcium carbide, placed a small piece in a dish of water, covering it by inverting a glass funnel. The rapidity with which the gas is generated was shown by the immediate agitation of the water, and by the ignition of the gas on the application of a light directly afterwards at the pipe end of the funnel.]

The PRESIDENT, in proposing a hearty vote of thanks to Mr. Glover for his interesting communication, mentioned that about two years previously he made experiments with carbide of calcium. At that time he had great difficulty in getting a supply. He had to wait quite three months for it; and then had to pay 1s. per lb. His experiments were not so much in regard to the employment of acetylene gas for lighting purposes, as to its use in lanterns for dissolving views. But he was not successful in this direction. Regarding the burners Mr. Glover had exhibited, he (the President) saw similar ones in use in Brussels two years ago.

Mr. P. SIMPSON (Rugby) seconded the motion, which was cordially endorsed by the members.

Mr. GLOVER, in responding, said he regretted he had not had time to deal with the subject in a more adequate manner. He started with the feeling that it was of little moment to them as gas engineers; but as he proceeded with the preparation of the paper, its interest and importance grew.

THE STANDARDIZING OF METER-UNIONS.

The HON. SECRETARY read a letter he had received from the Secretary of the North British Association of Gas Managers (Mr. R. S. Carlow, of Arbroath) on the above subject. Mr. Carlow, in his communication, said he was instructed, at the last meeting of the Committee of the North British Association, to communicate with kindred Associations regarding the proposal to standardize meter-unions, and to invite them to co-operate in the object in view. He suggested that, in the event of the proposal being favourably received, a Sub-Committee from each Association should meet in London, or some other convenient centre, in order that the whole subject might be fully discussed. The letter was accompanied by copies of the reports of the proceedings of the North British Association for the three past years; and from the copy for 1897, Mr. Meiklejohn read an extract referring to the question.*

The PRESIDENT agreed as to the necessity of standardizing meter-unions. The difficulty which prevailed in respect to these unions was due very much to the fact that the London makers had one standard and the Edinburgh makers another; and the unions were consequently not interchangeable, as they should be. Gas managers, however, had a very simple remedy. When giving orders for meters, they could instruct the manufacturers to make the unions interchangeable; and if they would not do so, they could decline to give them orders. Being such a simple matter, he thought that, if the meter makers were approached, they would soon put an end to the difficulty.

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* See "Reports of Gas Associations" for 1897, p. 150.

Mr. W. C. Jones (Kingswinford) considered it advisable that the Association should entertain the proposal of their North British friends. At present, he remarked, a gas manager was tied down to some extent to one maker, unless he had many different sizes of meter-unions in his district; but if they could legalize the standards throughout the country, in a few years all their meters would be fitted with standard sizes of unions. If, however, they left the matter to individual managers, what one might prefer his successor might not like. Those in charge of small works especially knew the disadvantage of having meters with different unions. If anything could be done by them as an Association, they ought to do it; and he would therefore be pleased to propose that a Sub-Committee should be appointed to confer with the Committees of other Associations with the view of legalizing standards for meter-unions.

Mr. R. O. Paterson (Cheltenham) said there could only be one opinion as to the advisability of standardizing the unions of meters. He thought it would be better, perhaps, if the meeting decided to leave the matter in the hands of the Committee of the Association, with authority, if considered expedient, to send a deputation to confer with deputations from other Associations, or at all events to deal with the matter in any way they thought fit. It was not for the members to discuss the merits or the *pros* and *cons.* of the question at such a meeting as that; and if Mr. Jones would withdraw his motion, he (Mr. Paterson) would propose that the matter should be referred to the Committee with power to send a deputation to the suggested conference if thought desirable.

Mr. Jones said he would have pleasure in withdrawing his motion, and seconding that proposed by Mr. Paterson.

On being put to the meeting, Mr. Paterson's suggestion was unanimously adopted.

This concluded the business on the *agenda;* but, before separating, the members partook of high tea.

MANCHESTER INSTITUTION.

ANNUAL MEETING, FEB. 26.

This Meeting was held in the Grand Hotel, Manchester. At the commencement of the proceedings, the chair was occupied by Mr. R. PORTER, of Elland, the retiring President.

The HON. SECRETARY (Mr. S. S. Mellor, of Northwich) read the minutes of the previous meeting, which was held at Bradford on Nov. 27, 1897; and they were duly confirmed.

NEW MEMBERS.

Mr. H. Peaty (Burslem) and Mr. F. W. Johnston (Mossley) were unanimously elected members of the Institution.

THE REPORT AND ACCOUNTS.

The HON. SECRETARY read the report of the Committee, which stated that, during the past year, twenty-nine new members were elected, two had resigned, two ceased membership under Rule 1, and one under Rule 17—leaving 130 members now on the roll. After detailing the business transacted by the Institution during the year of Mr. Porter's presidency, the Committee concluded by soliciting the continued assistance of the members, so that the success which has hitherto attended their efforts might be extended, and in the future become more prosperous and beneficial.

On the motion of Mr. R. HUNTER (Chester), seconded by Mr. A. H. SMITH (Darwen), the report and accounts were adopted.

ELECTION OF OFFICERS.

Mr. ISAAC CARR (Widnes) proposed that Mr. Shadbolt should be elected Senior Vice-President. He remarked that in Mr. Shadbolt they had a gentleman of vigorous intellect and action, who had proved himself to be in the van of all matters in connection with the advancement of their profession; and in his term of office he (Mr. Carr) predicted they would have a year second to none that had preceded it.

The proposition was carried unanimously.

Mr. W. NEWBIGGING (Manchester) then proposed the election of Mr. G. E. Stevenson as Junior Vice-President.

Mr. E. A. **Harman** (Huddersfield) seconded the motion; and it was carried.

Mr. Thomas Newbigging and Mr. Mellor were then re-elected Treasurer and Hon. Secretary of the Institution.

Mr. **Mellor** and Mr. **Shadbolt** briefly returned thanks.

Mr. H. Townsend (Wakefield), Mr. S. R. Ogden (Blackburn), and Mr. T. N. Ritson (Kendal) were elected members of the Committee; the first-named gentleman being chosen to fill the vacancy caused by the raising of Mr. G. E. Stevenson to the position of Junior Vice-President.

Mr. **Harrison Veevers** (Dukinfield) moved the re-election of Mr. W. Smith and Mr. T. Duxbury as Auditors of the Institution; and at the same time proposed that a vote of thanks should be accorded to them for their services during the past year.

Mr. W. **Prince** (Stoke-on-Trent) seconded the motion; and it was passed.

Mr. **Smith** briefly returned thanks.

Introduction of the New President.

Mr. **Porter**, in inviting Mr. W. S. Haddock, of Warrington, to take the chair, said he wished to thank all the members for the assistance and encouragement they had extended towards him during his year of office; and he solicited the same consideration for his successor.

Mr. **Haddock** then took the chair.

The **President** said, before reading his Inaugural Address, he would ask the members to return a hearty vote of thanks to the retiring President.

Mr. W. W. **Hutchinson** (Barnsley) expressed his pleasure in seconding the proposition, which was passed by acclamation.

Mr. **Porter** having returned thanks,

The **President** read the following

INAUGURAL ADDRESS.

Gentlemen,—I thank you for the honour you have conferred upon me by electing me your President for the ensuing year; and while I fully appreciate the difficulties before me, in filling a position which has been held by so many able engineers, I hope to carry out the duties of President in a manner which will be creditable to the Institution. I shall try to prove myself worthy of the trust you have placed in my hands.

An Institution of this kind is very valuable in bringing together the gas engineers of the district. It confers upon its members the benefits to be derived from the papers which from time to time are read upon subjects of the greatest importance and interest to all gas engineers, and the discussions arising therefrom, and in disseminating information with reference to the various new processes, patents, and discoveries, which are constantly being introduced, and the experience gained by the different members of the Institution in the practical working of the same.

I am very pleased to find, from the report of the Committee, that the Institution is in a very flourishing condition, and the membership is steadily increasing. I would remind you that, while we number 130 members, there are yet a great many gas engineers within the district who have not joined us; and I would urge on the members who have friends who are gas engineers in the district, to impress upon those friends the advantages to be derived from joining the Institution.

The duties of a gas engineer or manager are primarily to produce pure gas of stated quality, at the lowest possible price. To carry out these duties successfully, it is necessary that he should obtain a good supply of coal at a fair price, work it up in a scientific and economical manner, and dispose of the bye-products in the best markets. In the purchase of coal, it is usual to invite tenders for one, two, or three years' estimated consumption. Frequently as many as thirty to forty tenders are received, varying in price from as low as 7s. 6d. up to 15s. per ton delivered at the works.

This coal has to be valued according to the quantity and quality of gas, coke, tar, and ammoniacal liquor which can be extracted from it. Cyanogen may be included among the bye-products, where it can be recovered in such quantities as to make it profitable. When I was first called upon to recommend the purchase of a particular coal, I found that this was one of my most arduous and anxious duties. Warrington being situated in proximity to the Wigan and St. Helen's coalfields, the tenders from the Manchester, Yorkshire, Staffordshire, and North Wales coalfields generally proved to be of too high a price to compete with coal from the neighbourhood of Warrington, in consequence of having to add 2s. to 3s. extra for freight.

In arriving at the value of a coal, it is of great advantage to know as much as possible of the various seams of coal from which your supplies are obtained, and I have found very much valuable information in Baines's "History of Lancashire and Cheshire, Past and Present," from which I have extracted the following information.

The Lancashire and Cheshire coalfield is one of the richest and most productive in Great Britain. It extends from north to south; commencing in the north at Colne, in Lancashire, and running southward to Congleton, in Cheshire. At its broadest point, it is about 40 miles in width; extending from Todmorden on the Yorkshire border, to Whiston near Liverpool. The area is some 400,000 acres, or about one-fifth of the area of the counties of Lancashire and Cheshire. This coalfield contains about 120 seams of coal, upwards of 30 of which are now worked.

The Lancashire and Cheshire coalfield is usually divided into three divisions. These three divisions are: First, the upper, or Manchester, coalfield at Ardwick, Manchester; secondly, the middle, or principal, coalfield, extending completely across Lancashire, from Oldham and Ashton in Lancashire and Dukinfield and Poynton in Cheshire, to St. Helens and Wigan; and, thirdly, the lower coalfield, so called from having been originally deposited at the lowest depth of the sea, but which has now been forced to the highest level by internal convulsions, and extends over a great part of the hilly and mountainous regions of South Lancashire and Cheshire.

The upper, or Manchester, coalfield, at Ardwick, contains some 15 seams of coal, and the aggregate thickness of these seams is 30 feet.

Plans of the middle coalfield, drawn in 1865 by Mr. Dickinson, Inspector of Mines for the Manchester District, give the various strata of coal in four different districts: First, the district lying between Manchester, Bury, and Bolton, including the mines of Pendleton, Patricroft, Worsley, Atherton, and Hulton, containing 100 seams of coal, and the aggregate thickness of coal in which is upwards of 140 feet. Secondly, the neighbourhood of Oldham, Ashton, Stalybridge, and Stockport, including the mines of Dukinfield, Ashton, Oldham, and Poynton, containing 92 seams of coal, and the aggregate thickness of which is 126 feet. Thirdly, the St. Helens coalfield, containing 44 seams of coal, of the aggregate thickness of 74 feet. Fourthly, the Wigan coalfield, containing from 58 to 60 seams of coal, of the aggregate thickness of 62 feet.

The seams of coal in the lower coalfield are of great extent, running through the whole of the more hilly districts of Lancashire and Cheshire. In some places, coal is obtained at elevations of 1500 feet and even 1800 feet above sea level. There are 15 seams in this coalfield, having an aggregate thickness of 10 feet.

The Lees, or Dogshaw coal—a rich seam, 5 feet thick, in the Oldham district—is the last thick seam of coal, and is identical with the lower Woodley mine of Dukinfield, the Riley mine of Oldham, and the Arley mine of Wigan. At Harwood, it is very thin. The most complete section of the Wigan coalfield is probably obtainable at Pemberton, Springs Branch, and Bamfurlong, and is shown in the following table:—

Section of the Wigan Coalfield.

NAMES OF MINES.	PIT NO. 1.				PIT NO. 2.				Price per Ton at Pit.	
	Thickness of Mines.			Depth of Mines from Surface.	Thickness of Mines.			Depth of Mines from Surface		
	Yds	Ft.	In.	Yards.	Yds.	Ft.	In.	Yards.	s.	d.
First Yard	1	0	1	84		—		—	8	3
Second Yard . . .	1	0	3	94		—		—	8	3
Ince 4-feet. . . .	1	1	8	125	1	1	4	63	8	6
„ 7-feet. . . .	1	1	0	139	0	2	3	93	7	0
„ furnace . . .	1	0	4	161	0	1	4	113	6	9
Pemberton 5-feet. .	1	1	10	241		—		—	7	0
„ 2-feet* .	0	2	0	249	0	1	5	207	9	0
„ 4-feet* .	1	1	2	268	1	1	4	220	9	0
Wigan 5-feet†. . .	1	1	10	400	1	1	0	345	7	0
„ 4-feet‡ (*a*). .	1	1	5	432	1	0	4	381	7	6
„ 6-feet§. . .	2	1	9	458	2	1	0	411	7	0
Cannel		..		547	0	0	8	475	16	0
King coal‡. . . .		..		550	1	2	2	475	7	6
Ravine‖		..		597	3	0	1	503	..	
Yard	0	2	8	631	0	3	4	525	8	0
Bone		..		..		..		..	..	
Smith or Orrel 5-feet‡		..		..		..		..	..	
Arley or Orrell 4-feet¶	1	0	6	710		..		..	11	0

* First-class house coal. † First-class steam coal. ‡ Gas coal. § First-class steam and second-class house coal. ‖ Steam coal. ¶ Gas and house coal.

(*a*) With 5 to 15 inches of cannel.

The seams above of cannel cover only small areas. There are three seams of cannel in the Wigan district—the Wigan four-feet, King cannel, and the Wigan cannel. Collieries situated within a short distance of each other may raise two entirely distinct seams of cannel; and as cannel varies so much in quality, it is very important to know the exact seam from which it has been mined. The King coal and cannel increases in thickness from Bamfurlong, where it completely runs out, to Norley and Pemberton, where it is 2 feet in thickness. The Wigan cannel does not appear in the table given above. It is an entirely separate seam from the King cannel, and it is worked by the Ince Coal and Cannel Company, the Elms Colliery, and the Wigan Coal and Iron Company. This seam lies just above the King coal.

The following is a short table showing laboratory tests of coal and cannel in the Wigan district:—

Laboratory Tests of Coals and Cannels.

Name of Coal.	Cubic Feet of Gas per Ton.	Illuminating Power in Candles.	Coke in Pounds per Ton.	Ash in Coke, per Cent.
Wigan 4-feet cannel	15,400	39·88	1080	9·00
„ 4-feet coal and cannel	10,280	20·53	1368	6·00
Wigan 4-feet coal only	11,400	16·90	1320	8·62
Arley coal	12,000	18·41	1493	5·00
„ yard	11,100	18·57	1431	8·00
King cannel	12,100	23·58	1312	5·00
Wigan cannel	12,735	22·60	1415	4·98

The Lancashire coals taken as a whole are a superior class, yielding a good coke, and comparatively free from earthy or other impurities. Among these, the Wigan Arley mine may be regarded as almost the highest type of a gas and coke producing coal; and, taking the two qualities together, it is the best in the Lancashire district.

The following table shows the total quantity of coal raised and carbonized in the United Kingdom from 1894 to 1896:—

Year.	Total Quantity Raised. Tons.	Average Pit Price.	Coal Carbonized. Tons.	Gas Made. Cubic Feet.
1894	188,277,000	6s. 8d.	11,319,301	114,295,680,640
1895	189,661,000	6s. 0½d.	11,937,446	121,421,752,691
1896	—	—	12,296,739	127,041,603,412

Each gas engineer has to be guided by his own experience with regard to the particular kind of coal which it is most economical for him to purchase to produce gas of the required quality, which may vary in illuminating power from 14 to 22 candles. The quality of the coke and other bye-products must be taken into consideration. In many districts, members have succeeded, owing to favourable circumstances, in obtaining upwards of 75 per cent. of the first cost of the coal from the revenue derived by the sale of bye-products. The selection of coal also raises the important question of enrichment. At the works in charge of our members, the great majority enrich the coal by the addition of cannel only; other members use other processes, either in addition to, or without cannel. I find, from replies I have received in answer to a circular sent to the members, that all the well-known systems are in operation in the district. The following is a table showing, as far as I have been able to ascertain, the various enrichment processes in use in works in the district in charge of members of the Institution, with the extent of that use, and the cost. It will be seen from the table that the cost of enrichment with cannel varies considerably. At some works, where cannel can be purchased at a lower figure than coal, the enrichment costs nothing; at other works, the cost rises as high as 2d. per candle per 1000 cubic feet. Mr. Glover, of St. Helens, in replying to my circular, stated that by adopting the Peebles process he was enabled to work up a lower grade coal, which is raised in his district.

The Corporation of Warrington enrich with cannel; and I have not been able to find a sufficient reason to recommend them to change the process, though I admit I have been unable to go into the subject of enrichment by carburetted water gas to the extent our last President has done. This system, though not economical at Elland, must have been found so in many places, as it is being extended in London, Birmingham, Liverpool, and other towns, and adopted in Middlesbrough, Stockport, Halifax, and other places. Up to the beginning of last year, I estimate that carburetted water-gas plant had been erected for the production of 41 million cubic feet of gas. Since that time I am informed that orders have been received for plant to produce 27 million cubic feet per day.

Processes and Cost of Enrichment.

No. of Works.	Process.	Extent in Candles.	Cost per 1000 Cubic Feet per Candle in Pence, and Remarks.
1	Peebles	15 to 18¾	0·50
,,	,,	,, 18	0·93
,,	,,	,, 20	0·36 (material only)
,,	,,	17 ,, 21	0·75
,,	Maxim-Clark	18½ ,, 20½	1·00
,,	,,	,, 18	..
,,	,,	No details.	..
,,	Carburine	to 17	..
,,	Carburetting spirit	,, 17¾	..
,,	,, ,,	,, 17½	..
,,	Carburetted water gas	,, 19	..
,,	,, ,,	,, 18½	..
,,	,, ,,	,, 20	..
,,	Self-enrichment	,, 15	Nil
,,	,,	,, 17	,,
,,	,,	17½ ,, 18	,,
,,	Tatham's oxy-oil	,, 19	..
,,	Dinsmore	16½ ,, 19	..
54	Cannel only	..	Nil to 2

Owing to the adoption of carburetted water gas and other enrichment processes, the price of cannel has been considerably reduced, to the benefit of those works where it is solely used.

The Wigan four-feet cannel, which was sold at 41s. per ton at the pit in 1892, can now be purchased at 23s. per ton. The second grades of cannel are much reduced in price; but they have not fallen in value to the extent of the rich seams.

From the Board of Trade returns and other information, I have ventured to estimate the amount of cannel which was formerly used, but is now dispensed with at the various gas-works in the United Kingdom.

Enrichment Material other than Cannel used in the United Kingdom.

Enricher.	Quantity Used. Gallons.		Cannel Equivalent.† Tons.
Petroleum oil	46,312,324	..	617,491
Petroleum spirit*.	1,785,083	..	35,701
Total	48,097,407	..	653,192

* Includes naphtha, benzol, carburine, and canneline.

† 50 gallons of spirit and 75 gallons of petroleum oil taken as equivalent to 1 ton of cannel, yielding 12,000 cubic feet of 34·8 candle gas.

There have been no important changes in the processes for the manufacture of gas of recent date. In the retort-house, regenerative settings for heating the retorts and stoking machinery are rapidly being brought into more general use. The inclined-retort system is also extending. Up to twelve months ago, there were 4091 retorts built upon this principle. The Secretary of the Automatic Coal-Gas Retort Company, Limited, reports that there are now over 2024 retorts in contemplation, or an increase of 50 per cent. By the use of the inclined-retort system, the Brentford Gas Company report a saving of 1s. 7d. per ton over manual stoking. There are few large works that have not availed themselves of one or other of the many excellent mechanical systems in use for economizing hand labour.

The present system of purifying gas has been general during my experience; whereas much progress has been made in all the other sections of manufacture. The use of the Wanklyn bottle for estimating the quantity of impurity in the gas enables the manager to direct the operations of the purifiers with more certainty and greater economy. An advantage is to be derived by having fewer boxes of greater area, rather than more boxes of reduced area. The boxes at the Warrington works have recently been reduced to one-half in number and more than doubled in area, by coupling together two adjoining boxes. When purifying the same quantity of gas, the larger boxes give from 25 to 50 per cent. more duty per square foot than was obtained prior to the alteration. Those members who visited the Preston Gas-Works in May last, saw purifiers of immense area. These purifiers Mr. Green finds cheap to erect, and very economical to work. [For a description and illustration of the purifiers, see *Journal of Gas Lighting*, Vol. LXVI., p. 918.] Similar purifiers have recently been erected at the Sheffield Gas-Works. A new and more satisfactory method of purifying gas than the one now in use is much to be desired. The opening of the purifiers always gives rise to some danger; and many accidents have arisen in the purifying of gas as now carried on. The work to be performed is of a disagreeable nature, and to some extent objectionable to those living in the neighbourhood of a gas-works. A large area of land is required; and the building and plant are costly both to erect and maintain. The paper by Mr. Stelfox on the Claus system, will deter many gas companies from making further trials on similar lines. This is to be regretted, as the Belfast working shows that gas can be purified by this process. The cost appears to be due to the loss of ammonia in the carrying out of the process. Theoretically there is no loss; and the system is an ideal one on paper. We are all indebted to the Belfast Corporation for the persistent manner in which they have persevered with the Claus process, and also to Mr. Stelfox for making known to us the results of their investigations. [See *Journal of Gas Lighting*, Vol. LXIX., p. 1475.]

The production of sulphate of ammonia continues to increase, as shown by the following figures taken from Messrs. Bradbury and Hirsch's "Review of the Market for Sulphate of Ammonia" for the past year:—

Total production, 1892	149,850 tons
" " 1897	202,000 "

being an increase of about 35 per cent. in five years. The price of sulphate has increased from £7 10s. per ton in June last, to £10 per ton at the present time. If the present large increase in the production of sulphate continues, it will be necessary to find fresh outlets for its consumption. An Association has been formed to bring the great value of sulphate of ammonia before the public, and also to increase its demand and uses. It is advisable that all gas concerns should join the Association, and do everything in their power to increase the demand for sulphate. A larger demand will strengthen the price of ammonia compounds, and benefit all gas producers, whether they distil or sell ammoniacal liquor. In many towns the manner in which the effluents from the sulphate still are disposed of will require to be changed. Mr. J. F. Bell, of Stafford, proposed to settle the effluent liquor in a tank, and use it for quenching coke, washing gas, &c.; but he has not yet been able to carry out the work. On our visit to the Nottingham works, Mr. Chester pointed out that all the effluent was evaporated to dryness in a boiler.

Owing to the great fall in the price of tar products in 1892, the purchaser of the Warrington tar was unable to carry out his agreement; and the Corporation were thus compelled to enter into fresh arrangements for the disposal of their surplus tar. The difficulty of selling it at what they considered a fair price induced them to put down a tar-distilling plant. This cost them rather more than £1000. The still and other plant were designed to distil a charge of 10 tons in one day. The plant has worked well since it was laid down in 1893; the following table showing the results:—

Year.	Coal Carbonized. Tons.	Tar Realized.	Revenue from Tar Per Ton of Coal Carbonized.
1893-4	21,000	£1651	1s. 6·8d.
1894-5	23,061	2641	2 3·4
1895-6	24,933	2269	1 9·8
1896-7	26,641	2297	1 8·6

Of the legislation of the past year, the only Act which affects gas managers is the Workmen's Compensation Act, 1897. To them, as to all employers of labour, it is of the utmost importance. This Act, which applies to all "factories" within the meaning of the Factories and Workshops Acts, 1878 to 1891, almost unrestrictedly fixes the employer with liability to pay compensation to a workman personally injured, or to the "dependents" of a workman killed by accident, arising out of, and in the course of, his employment. The restrictions are, that the employer is not liable for any injury (1) not disabling the workman for at least two weeks from earning full wages; or (2) attributable to the serious and wilful misconduct of the workman. There are also restrictions as to amount; the workman being only entitled to receive in case of injury, where total or partial incapacity for work results from the injury, a weekly payment during the incapacity after the second week not exceeding 50 per cent. of his weekly earnings during the previous twelve months, if he has been so long employed; but if not, then for any less period during which he has been in the occupation of the same employer—such weekly payment not to exceed £1. In case of death, the compensation to the "dependents" may reach the sum of £300, but cannot exceed it. Where any weekly payment has been continued for not less than six months, the liability therefor may, on application by the employer, be redeemed by the payment of a lump sum; and if this sum cannot be agreed upon, it is to be settled by arbitration. In cases of total incapacity, therefore, there is no limit as to the amount of compensation which may have to be paid; and the Act does not give any basis from which it might be calculated. "Contracting out" of the new Act is only allowed upon a certificate by the Registrar of Friendly Societies, to whom the terms of the proposed contract will have to be submitted, that he has inspected and approved an arrangement of insurance between the employer and workman contracting out. It is otherwise absolutely prohibited. The Act comes into operation on July 1, 1898. I think it will be found that matters will work much better and smoother for us under the Act, if a system of insurance can be arranged with the workmen, and the sanction of the Registrar of Friendly Societies obtained; but I commend this to your careful consideration.

The electric light is coming into more general use, as shown in the following table:—

Year.	Number of Companies.	Total Capital.	Number of Municipal Undertakings.	Loans Authorized.	Board of Trade Units Sold.
1895	38	£5,831,073	33	£1,967,000	30,203,766
1896	58	6,647,792	57	3,509,317	43,303,176

During the past year, 8 Electric Lighting Provisional Orders have been obtained by companies, and 42 by municipal bodies. Garcke's "Manual of Electric Undertakings" states that the cost of producing and distributing the electric current has fallen from 4·07d. in 1895 to 3·37d. in 1896, exclusive of capital charges. Taking gas of 18½-candle power at 2s. 10d. per 1000 cubic feet, and reckoning that 4 watts of electric current furnish 1-candle power, it would require electricity to be sold at 2·3d. per unit to give the same amount of light for the same cost.

As acetylene gas gives such a beautiful light, and so many patents have been taken out for its production (as many as 119 during the past year), I obtained the following information from Messrs. Thorp and Marsh, of Manchester, who have been experimenting with the gas for the last eighteen months, with a view to its introduction for general lighting. The gas is produced by mixing carbide of calcium and water. The present selling price of carbide in large quantities is £16 per ton. One pound of carbide is guaranteed to yield 5 cubic feet of gas having an illuminating power of 240 candles. The general method of producing gas is by adding water to carbide, which Messrs. Thorp and Marsh found both dangerous and unsatisfactory. They have therefore adopted a system of adding the carbide to the water. They state that the gas in its pure state, when burned, gradually chokes up the burners; and they have patented an arrangement for adding two volumes of air to one volume of the gas, which they find satisfactory to burn in ordinary coal-gas burners. I may say that the same firm have patented a safety-valve. They claim for this valve (which applies to acetylene or coal gas) that in cases where the light which has been left to burn all night has been extinguished by a stoppage of the supply of gas, the valve, which works automatically, will close and prevent any escape of gas on resuming the supply.

The consumption of gas has been greatly increased by the introduction of coin meters among the working class, who previously had rarely burned gas, and who, but for the introduction of this class of meter, never would have done so. To people of this class, a supply of gas by coin meters is a great boon, and much appreciated. It is very much safer than lighting by oil, which it is rapidly superseding; and the cost in most cases is less. The extra cost of supplying gas by coin meters has not yet been determined in many towns with any degree of accuracy, as the system has not been established sufficiently long to obtain reliable information. From the accompanying table great differences are shown in the cost of using coin meters, upon which I considered it advisable to obtain information. [See plate.]

In Warrington, the coin meters, fittings, boiling-burners, and pipes, including labour in fixing same to the 2500 meters which were in operation on March 31 last, cost the Corporation rather over £6000. The cost of collecting the coins and reading the indices, but excluding watering, came to 1s. per meter. Taking a large number of meters which had worked twelve months, the average consumption was 8000 cubic feet. In the case of 790 meters, the house pipes, fittings, and all cost, was borne by the Corporation; and the meters fixed are set to supply 23 cubic feet for a penny, or an extra charge of 9½d. per 1000 cubic feet on the price of gas to ordinary consumers. Then 1710 meters are fixed in houses already supplied with internal pipes and fittings. The meters in this case are set to supply 25 cubic feet for a penny, or an extra charge of 6d. per 1000 cubic feet. Taking the meters as consuming 8000 cubic feet each per annum, the extra income from these 2500 meters—viz., 790 at 6s. 4d., and 1710 at 4s. each—should yield £592. Deducting from £6000 the cost of 2500 ordinary 3-light meters, we obtain £3683 as the extra cost of the coin-meter system. Allowing one-fifteenth for redemption of the debt, there remains £347—a sum not more than sufficient to pay for the extra cost of collecting the coins, interest on the outlay, and to meet the probable cost of repairs on the expiration of the makers' guarantee.

32	½	..	550	550	..	4 2	4 0	4 0	Nil	Nil	..	18	4 7	5	S.M.P.B.	..
33	1½	..	730	730	..	2 10	2 0	..	..	..	6,000	25	3 4	6	..	4,380
34	1	..	1100	1,100	15·6	2 8	1 6	2 0	..	Nil	8,000	25	3 4	8	M.P.B.	8,800
35	3	172	10	182	..	3 9	2 6	3 4	..	Nil	5,000	20	4 2	5	S.M.P.B.	910
36	3	134	266	400	..	2 5	2 0	2 6	Nil	All	7,500	28½	2 11	6	S.M.P.B.	3,000
37	1½	..	6	6	..	4 4	Nil	Nil	..	7	..	15	5 1	9	S.M.	..
38	2	600	..	600	..	2 3	Nil	Nil	Nil	All	8,000	27	3 1	10	S.M.P.B.	4,800
39	2	..	158	158	14·2	3 11	2 0	2 6	5 0	All	7,000	20	4 2	3	S.M.P.	1,116
								2 8	Nil	All	10,000	25	3 4	10	S.M.	50,000

Before concluding my address, I wish to express my thanks to various members for the many kind wishes and the valuable information which they have so willingly supplied, but which time has prevented me from acknowledging individually.

Mr. Ritson, in proposing a vote of thanks to the President, said when he first heard that Mr. Haddock was to be their President, he expected to hear a very fine address; and in this expectation he had not been disappointed. They must all appreciate the versatile manner in which he had gone over matters connected with the gas industry. Mr. Haddock's association with Mr. Paterson had given him a wide experience in coal matters; and he (Mr. Ritson) for one was glad that the President had brought forward the question that day in so lucid a manner.

Mr. Veevers seconded the motion; remarking that the fact that Mr. Haddock now occupied the very position at Warrington which he himself filled forty years ago gave him peculiar pleasure in doing so.

Mr. Isaac Carr said he wished to add a word of thanks to Mr. Haddock for his very excellent address. He felt a sort of personal responsibility for Mr. Haddock occupying the position he did that day. If it had not been for the pressure that he (Mr. Carr) brought to bear upon him in the initial stages, Mr. Haddock would certainly not have taken office. He felt that Mr. Haddock could do the work in an excellent manner; and the address they had just listened to was a justification of the position he (Mr. Carr) then took up. There was much that was of interest in the address; and it would be read with advantage by those who were unfortunately absent.

The resolution was passed unanimously.

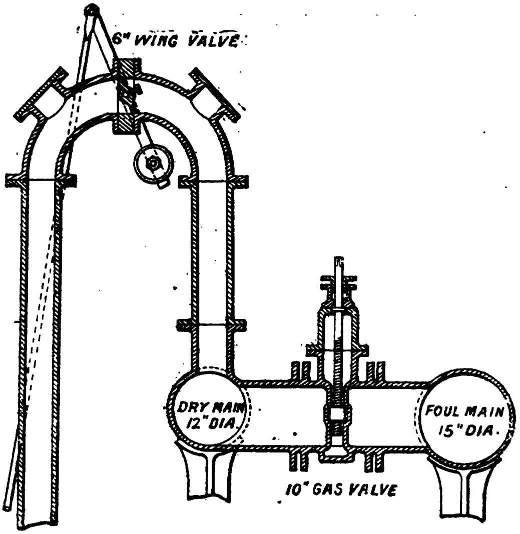
Mr. H. Kendrick (Stretford) read a paper on

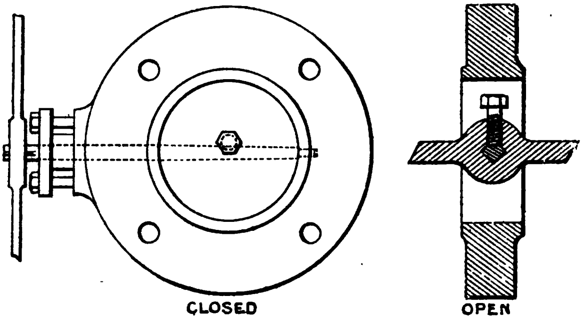
AN EXPERIENCE WITH DRY MAINS.

The question of which is the most economical to use in the retort-house, wet or dry mains, is one that has agitated the gas world for a long time, in however only a minor degree; and it is with the object of endeavouring to bring the subject to a head, and obtain all the opinions possible, that I have brought the matter before you to-day. My experience as a manager of a gas-works has been very short compared with most of those to whom I am speaking; and I hope that this endeavour will not meet with any disfavour in consequence. Before I entered upon my duties at Stretford, I had no practical experience of dry mains, although I had theoretically a fair knowledge of the type which I found in course of erection when I first took charge of the gas-works.

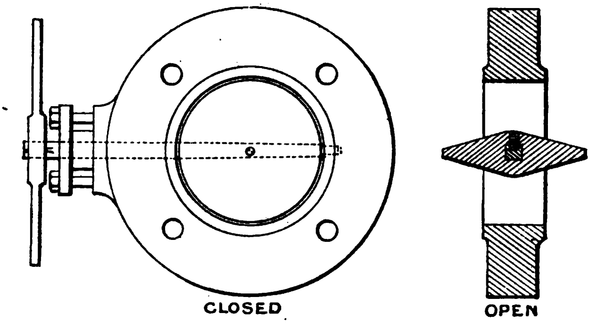
A description of the plant will not be out of place here. The ovens each contain eight through ⌓ retorts, 22 in. by 16 in., set over Klönne regenerators and producers. The mouthpieces have self-sealing lids; and the ascension-pipes are 6 inches, tapering to 5 inches in diameter. The arch-pipes are 5 inches in diameter, enlarged to 6 inches in the centre, where the valve is inserted; and they are connected to the receiving main by 5-inch pipes. The receiving main is 12 inches in diameter; separate ones being provided for each oven. The gas passes away to the foul main through a 10-inch connection and valve; the foul main being 15 inches in diameter, and serving eight ovens. The two foul mains are connected to an 18-inch main at the end of the retort-stack and to the condensers, the inlet and outlet of which are 18 inches in diameter. The wing valves, which are 6 inches in diameter, are worked from the stage-floor by a long lever; being closed by lifting up the rod, when the retort-lid is opened, and opened by drawing down the rod after charging—thus making a clear way for the gas. The lever rods are provided with a hook, for fastening them to the cross-bars of the mouthpieces, to keep the valves open, as the valve-levers are counterbalanced to ensure them keeping the valves closed when the lever-rods are released. The wing-valves are of the ordinary pattern, as shown by the illustration.

The whole of the brick and iron work was given into the hands of one contractor, who sublet the ironwork. The order was unfortunately placed very late in the season, so that we were not able to put the ovens to work until the beginning of December. Two were then started, under the supervision of the contractor's foreman, who remained a fortnight at the works to instruct the men and see that all things worked satisfactorily. We started with 2½-cwt. charges per mouthpiece every four hours; but after four days we were so troubled with stopped pipes that we had to alter the weight to 3 cwt. per mouthpiece, drawing and charging them five times in the 24 hours. This alteration reduced the number of stoppages very considerably; but then another difficulty arose. The wing-valves became fast; and in endeavouring to loosen them by the levers, we broke the valve-spindles. We then had to prop open the valves until we could take them out and put in new spindles. When a valve had to be propped open, the gas always worked back from the receiving main, down the ascension-pipe, into any retort that was being drawn and charged, as we found it necessary to work





WING VALVES AS SUPPLIED.



WING VALVES AS ALTERED.

FIG. 3.—DRY MAINS AND WING VALVES FOR RETORT-SETTINGS.

with 2-10ths or 3-10ths back-pressure in order to keep up the illuminating power. I have often seen retorts so full of gas that it has been impossible for the stokers to see how to put in the first shovelful of coal; and as the valve-spindles were constantly breaking, the loss of gas was a frequent occurrence. Upon examining the wing-valves, I found that when new they were practically air-tight, and in addition were so thick and clumsy across the centre as to form a very considerable obstruction to the passage of the tar-laden gas; and besides this, the valves were fastened to the spindles by a set-screw, which projected considerably above the body of the valve. At my suggestion, the Contractor provided new wings of a much lighter pattern, which were fastened to the spindle with a grub-screw (as shown by the drawing), and not so good a fit as the first; $\frac{1}{16}$ inch play being left all round. There was now considerable relief, the valves not becoming fast so often; but we were never free from the nuisance of the gas working back down the ascension-pipes. On the evening of the 22nd of December, we noticed that the gas seemed to have great difficulty in passing up the ascension-pipes; and on examining the receiving mains, we found there was a considerable accumulation of pitch, but apparently not so much as to give any reason for alarm. By the morning, however, we found that the tar and liquor from the mains above had been blown over the arch-pipes into the retort mouthpieces; and the coal, for about 4 feet in the retorts, was drawn out as raw as when it had been put in five hours previously. By mid-day we had to shut off the ovens altogether, as we found that the 10-inch gas-valves were practically blocked with pitch. We fortunately had a good stock of gas, and the weather remained favourable; so that we were just enabled to pull through, by the time we had got two more ovens ready for work.

When we took out the 10-inch gas-valves on the four sections, we found that they, as well as the receiving mains, were completely blocked with hard pitch, and that a considerable quantity had found its way into the foul main. Thinking that a good deal of the trouble might have arisen through the high heats of the first few days, we cleaned all out thoroughly, and put them to work again. But they were as bad as ever in less than a month; and this was repeated a third time. In the meanwhile, we had substituted steel for wrought-iron spindles in the wing-valves; but this alteration made no permanent improvement. They did not break so often, certainly; but it was a regular thing to have to change two valves every day, on account of the broken spindles. The above method of cleaning the dry mains of thick tar and pitch was very expensive; so I had a 6-inch hole cut in the back of the foul main, opposite each valve, through which the valves and 10-inch connecting-pipes were scraped out every alternate day. This, however, was not sufficient; and during the remainder of the time they were working, the valves were cleared every twelve hours. Often a bucketful of thick tar and pitch would be taken out of each valve. We worked the ovens in this manner until the following autumn, when my Directors decided to substitute wet mains for the dry ones; and although we are now working with higher heats than formerly, we are obtaining better results without any of the trouble.

I have given the question of the stoppages a good deal of thought, in order to arrive at the cause. I did not consider that our heats were excessive, as lowering them made no improvement. The coals we used were principally from the Wigan district, with an admixture of 47 per cent. of second-class cannels, mostly from the same fields. This large proportion is necessary, as we supply 19-candle gas and only use oxide of iron in our purifiers; our standard burner for testing the gas being the No. 1 London argand (16-candle burner). The gas is therefore comparatively rich, and yields a large quantity of tar —viz., 15·46 gallons per ton of coal; and it is to this circumstance that I attribute the bulk of our misfortunes. I have made an attempt to support my theory by obtaining evidence from other gas-works, with a certain amount of success; and I here express my grateful thanks to those brother engineers who have so readily given the information asked for, and which I have here tabulated. [See pp. 66, 67.]

It will be seen from the table that the dry-main plants are practically the same in all the cases, and that the wet-main plants differ only in respect to the dip-pipes and flushing arrangements. There is considerable variation in the sources of the coal supply; and in no case do they agree with the Stretford district. The percentages of cannels used can be practically ignored with the exception of the gas-works "F;" and there wet mains are in use. The yield of gas per ton, with one exception, in each system is practically identical; while the illuminating power of the gas supplied is in each instance considerably below the Stretford standard. Those most nearly approaching it are the gas-works "E" and "F," where wet mains are in use. It will also be noticed that the yield of tar per ton varies with the quality of the gas supplied. From the foregoing particulars, I claim a very clear argument in favour of my theory, that the

Gas-Works.	Mains in Use.	Dips, Anti-Dips, or Valves.	Furnace.	Size of Retort and Number in Ovens.	Diameter of Ascension and Arch Pipes.	Size of Hydraulic or Dry Main.	Tar Overflows or Flushing Pipes.
A	Dry	6-in. wing valves.	Klönne.	22 in. × 16 in. 8 retorts.	6 in. to 5 in. 5 inches.	12 in. dia.	None.
B	„	„	„	„	„	14 in. „	„
C	„	5-in. „	„	„	„	14 in. „	„
D	„	„	„	„	„	14 in. × 16 in.	„
Stretford . . .	„	6-in. „	„	„	„	12 in. dia.	„
E	Wet.	Anti-Dips.	Klönne.	22 in. × 16 in. 8 retorts.	6 in. to 5 in. 5 inches.	24 in. × 25½ in.	Both.
F	„	„	Generator.	20 in. × 15 in. 7 and 8 retorts.	„	17 in. × 20 in.	Tar overflows only.
Stretford . . .	„	Dips.	Klönne.	22 in. × 16 in. 8 retorts.	„	21 in. × 24 in.	Both.

Gas-Works.	Do the mains and gas-valves become pitched up?	Place whence Coal was Obtained.	Percentage of Cannel Used.	Yield of Gas per Ton.	Illuminating Power of Gas Supplied.	Tar per Ton of Coal.	Does the gas work back down the ascension-pipes?
				Cub. Ft.	Candles.	Gallons.	
A	Only when working with high heats.	Lancashire. Derbyshire. North Wales.	1·00	10,600	15·50	10·20	When working with back-pressure.
B	Not during the last 12 months.	South Yorkshire and Durham.	1·28	10,816	17·39	12·28	No.
C	No.	Lancashire. Derbyshire. North Stafford. North Wales.	3·50	10,800	16·50 to 16·75	11·00	,,
D	Occasionally.	Derbyshire. North Wales.	None.	11,500	15	13·00	,,
Stretford . . .	Yes; about every four weeks.	Wigan district.	47·27 All bastard.	10,647	18·97	15·46	Yes.
E	No.	Burnley district.	None. Maxim carburetter	11,300	17·50	14·00	No.
F	Occasionally.	Wakefield district.	10 and Maxim carburetter.	10,300	17 to 18	13·00	Sometimes
Stretford . . .	No.	Wigan district South Yorkshire.	30·51 Half best. Half bastard.	11,275	18·89	15·94	No.

poorer the gas the less is the quantity of tar to be deposited on the valves and spindles and in the dry main; therefore there is not so much likelihood of stoppages from that cause. Then the yields per ton of gas-works "A," "B," and "C" are practically the same as those obtained by myself with dry mains; thus proving that the heats of the retorts at Stretford were not excessive, as is also borne out by the much better yields per ton obtained during the past half year. The difference in the sizes of the receiving or dry mains is, I am afraid, a factor in the cause of the stoppages; and this is borne out to a certain extent by the experience at gas-works "A," where stoppages occur when the heats are high.

There are certain reasons that make it injudicious on my part to pass a wholesale condemnation on the system: First, the system, with slight modifications, is in successful operation in other gas-works, where the conditions are rather different from those in existence at Stretford. Secondly, the character of the coals and cannels carbonized is not the same. Thirdly, the percentage of cannel used is more, and the illuminating power higher; the gas probably being richer than actually represented by the figures, owing to the absence of lime purification. Lastly, the large yield of tar per ton will make the foul gas more difficult to deal with when working with tight-fitting valves, spindles, and stuffing-boxes, and a smaller receiving main than is in use with poorer gas. I am therefore of opinion that dry mains worked with wing-valves as described to the members in the earlier part of this paper, are not suitable plant for the manufacture of a rich or comparatively rich gas, whatever they may be for the poorer gases which are supplied by Midland and Southern works.

The system in use at gas-works "E" combines the advantages of both wet and dry mains. The dip-pipes and hydraulic main are of the ordinary pattern, with the addition of a slide-valve made in the side of each dip-pipe, above the level of the seal. This slide-valve is worked by a rod passing through a stuffing-box in the hydraulic main cover, and a lever and rod from the stage floor, as is the case with dry mains. The wet main, combined with the flushing arrangement, entirely prevents the formation of pitch in the hydraulic main; and when the slide-valve is closed, it cuts off the face of the seating any thick tar which may be deposited there, and working in wedge-shaped guides always makes a tight joint, so that it is practically impossible for gas to escape down the ascension-pipes when the retorts are opened.

At gas-works "F" another system is in use, and the following is a description by the Engineer of the works:—

> The principal factor in the arrangement is the slide-valve, which is opened and closed by means of a lever and chain extending to the retort mouthpieces. When the retort is charged and closed, the slide-valve is opened by means of the chain; and the gas is thus allowed to go forward into the foul main without coming into contact with the liquid seal in the hydraulic main. A dip-pipe, however, is provided altogether apart from the slide-valve (though close to it); and, if necessary, the gas can be carried away by the usual dip arrangement, in which case the slide-valve will be closed. When the retort is being charged, the slide-valve is closed. Occasionally, during the operation of charging, gas (if working with back-pressure) comes down the ascension-pipe; the cause presumably being that the slide-valve does not shut off perfectly tight. We work as near as possible with a level gauge; and the dip-pipes have about 2 inches of seal. We are a little troubled with stoppages in the last condenser of a series of four, and find the cause to be the deposition of fine ashes. These apparently are carried forward through the anti-dips with the tarry vapour, and accumulate at the point named. With us, in this respect, the anti-dips are disadvantageous, for I believe that the fine ashes would, with a liquid seal, be arrested in the hydraulic main, and be carried away with the other residuals condensing therein.

The supporters of the dry-main systems claim certain advantages by the use of their particular plants. First, the cost of the installation is less than with wet mains; secondly, more gas per ton of coal is obtained, and as the exhausters can be worked at level gauge, there will be no back-pressure in the retorts, and consequently no leakage of gas into the setting; thirdly, there is little or no carbon deposited in the retorts, and consequently no extra fuel is required in burning off the charges, and the retorts last longer, as they are not damaged so often by de-scurfing. In anti-dip systems, with a wet main, the cost of the installation will be more than that with wet mains and dip-pipes; but the second and third claims are put forward as applying to those systems as well as to the former.

I am prepared to admit that the first claim will have to be allowed. The cost for dry mains should be less than for wet mains, when provided with flushing-pipes, tar overflows, and weir-valves; but allowance must be made for the expensive wing-valves, levers, and rods, and the additional lengths of the ascension-pipes, which will bring down the extra cost of the wet mains to about £13 per single oven—a not very large amount, when it is remembered that the users of dry mains say that they clean out the accumulation of pitch every summer, the cost of which, in my experience, is quite equal to the interest upon the extra outlay. Secondly, I am not prepared to admit that any great gain results from the use of dry mains or anti-dips. If there is more gas produced per ton, the illuminating power will be lower, and cannel or other enriching material must be used in order to make good the deficiency. Where a low-grade gas is supplied, this, of course, is not so important as with a high-grade gas. It is a well-known fact that fire-clay retorts are more or less porous, and that a light gas, such as hydrogen or methane, passes through a porous medium much quicker than a heavy gas, such as ethane or the higher hydrocarbons; so that when dips are in use, the slight back-pressure results in a larger percentage of the light gases passing into the setting through the pores of the retorts, leaving the gas that passes up the ascension-pipes richer than is the case when anti-dips are used. When using dry mains, the make of gas per ton at Stretford was 10,647 cubic feet; but after the dry mains were replaced by wet, we obtained 10,874 cubic feet. The coals and cannels being the same in both cases, I attribute the increased yield to the absence of loss down the ascension-pipes, and the higher heats I was enabled to work at. Thirdly, there will be little or no deposit of carbon in the retorts when working with wet mains, if the seals are kept as light as is consistent with safe working, and the vacuum kept to within 2-10ths or less of the seals; so that the claim of less fuel and a longer life applies equally well to wet mains worked under the foregoing conditions.

When such results as I have been able to attain are within the reach of all, when working with wet mains and materials of the same quality, I should not be prepared to recommend anyone who has to produce gas of good quality to make use of dry mains, as, taking all things into consideration, I am of opinion that the disadvantages far outweigh any advantage that is claimed for them. This opinion is entirely based upon my own experience of the system, and is borne out to a certain extent, for similar reasons, by gentlemen I have consulted, who declare that they prefer wet mains to dry, but have to work with the plant they have at their respective works.

In conclusion, I hope that I have placed this question before you in a clear and interesting manner; my sole reason for bringing it forward being to gain more knowledge, which I am certain I shall do from the wider and more varied experience of members of this Association.

Discussion.

The President, in inviting discussion, asked those who had used dry mains to give their experience.

Mr. HARRISON VEEVERS said, after an experience of 18 years, he was perfectly satisfied with dry mains. If the discussion on this subject could be deferred to the next meeting, he should be happy to produce drawings of the apparatus he had used. The first experience he had had with dry mains had taught him a great deal. At that time he charged the retorts for six hours; but he soon found that they became choked, and this caused him to ascertain how much gas he was getting between the fifth and sixth hours, so as to see whether it was worth while carbonizing for six hours. The conclusion he came to was that five hours were quite sufficient. He had been able to entirely obviate the stoppage of the valves, and had not for years had a valve that became choked with pitch.

The PRESIDENT asked if Mr. Veevers used winged valves.

Mr. VEEVERS said no; they were disc valves. This matter could be very much better illustrated by diagrams than by any description he could give. When he found the valves were getting choked, he put a cistern on the top of the ascension-pipe; and the water which was condensed in the earlier part of the charge was evaporated in the latter part. His plan was different to the one shown in the paper. By his arrangement if there happened to be a block in the main, the gas was not stopped, but simply went into an ordinary hydraulic main. He wished to call attention to one thing which Mr. Kendrick had spoken about, and that was the formation of carbon in the retort. In his opinion, it was not percolation of gas through the retort that caused this, so much as the breaking up of the hydrocarbons by the intense heat of the retort liberating the hydrogen in the carbon. If the matter should come up at the next meeting, he should be glad to exhibit a cartoon showing the system which he had adopted, and with which he was very well satisfied.

Mr. J. H. BREARLEY (Longwood) could sympathize with Mr. Kendrick in the difficulties he had experienced. His mains had not been so bad; he had a wet seal, coupled with a slide-valve called "Meiklejohn's anti-dip." He would strongly advise those engineers who had not yet adopted the valve system not to do it. At the same time, there was the advantage of getting the gas quickly away. There was not so much breaking up of the hydrocarbons in the retorts with the wing-valves and the slide-valves as with the seal. In the letter he had written to Mr. Kendrick, he referred to the trouble he had had with stoppages in the condensers. With the fourth condenser, he found once a month or six weeks a deposition of fine ashes in the bottom of the condenser, which, if it were not removed, would cause a stoppage. He had been knocked up at five o'clock in the morning that very week from this reason. As to the illuminating power, he did not see why it should suffer with the dry main if they had an exhauster well governed. He had obtained 17 to 17½ candle gas repeatedly from ordinary Yorkshire coal. Of course, it was a good quality of coal, but not cannel. He could quite imagine that they were troubled with stoppages in the wing-valves; but he had experienced no stoppage with the slide-valves, although possibly he would have done so if they were not well cleaned out every summer. He should like to ask Mr. Kendrick the percentage of cannel he used, as he had not seen it stated in the paper.

Mr. KENDRICK replied that he used 47 per cent.

Mr. BREARLEY said this accounted for the extraordinarily large make. He did not see that there would be any difference in the make with wet mains and dry mains. It was purely a question which worked best with the least amount of trouble.

Mr. S. MERRELL asked Mr. Kendrick what weight of charge he was working with at the present time.

Mr. KENDRICK replied 3 cwt. per mouthpiece.

Mr. E. A. HARMAN (Huddersfield) said he listened with great interest to the paper. There were so many points in connection with the subject, running on similar lines to the hydraulic main, that it was impossible to keep them distinct. The President in his opening remarks said that those who had experience of dry mains should take part in the discussion; but his (Mr. Harman's) experience was very small in this direction. The placing of the throttle-valves in any portion of the ascension-pipe—either in the arch or in the vertical pipe—seemed to his mind to be almost fatal to the satisfactory working of dry mains. They had sufficient difficulty with stopped pipes already; and placing an obstruction right in the centre of the pipe was certainly a very weak feature of the arrangement. The anti-dip system, which overcame the evil to a certain extent, could hardly be considered as having any connection with the dry main. With the anti-dip, there was liquid in the main for sealing the dip in. It seemed to him that the temperature of the dry main must be considerably higher than in the case of the hydraulic main. He did not know whether Mr. Kendrick could tell him what the temperature of the dry main at Stretford was when he was conducting his experiments. It also seemed to him that the hydraulic main assisted slightly in the matter of purification. The fact that the gas had to bubble through thin tar and ammoniacal liquor must cause a considerable amount of the impurities of the gas to be absorbed. He never made experiments with the gas before and after it left the hydraulic main; but he had no doubt at all that a considerable amount of the impurities were really extracted in the hydraulic main itself. It seemed a most simple matter to experiment with a system of dry mains, if they felt disposed to do so. The only point was to be sure that they stopped up the ascension-pipe at the mouthpiece during the moment of charging and drawing—of course, taking all due precautions of emptying the hydraulic main previously, and having an independent exhaust governed down to at least 1-10th back-pressure. He had heard people who used dry mains speak very highly of them. One engineer had told him that he would certainly work with dry mains in preference to a hydraulic. This gentleman informed him that he had no difficulty in adjusting the seals, but had previously had great difficulty in adjusting the levels of the hydraulic main—not merely when he started to work, but after the retort-bench had heated up. In consequence of the expansion of the brickwork, the mains were thrown out of level both longitudinally and transversely; and hence his seals were most irregular. Then again this gentleman had mentioned that he had had the experience of a broken dip-pipe when using a hydraulic main. All these difficulties would be overcome by the adoption of dry mains. There were many other points of interest and importance in connection with the subject, which he was sure they would do well to experiment with, either on a small or large scale. Where the hydraulic mains were (as they were at his own works) supported independently of the retort-bench by means of cross girders, the difficulty of obtaining level seals was not so great as it would otherwise be; but even then there were difficulties experienced through the variations in the seals. Unless the seals were kept adjusted to an exact level, there was a danger of the gas momentarily going up the ascension-pipe on one side of the bench, instead of equalizing itself between the two benches. He had discovered this by putting his hand on the pipe at one side and finding it quite cool, while on the other side of the bench it was far too hot for the hand; and yet the seals had shown by the dipping to have been nearly alike. Such a sudden rush of gas on one side was necessarily liable to produce stopped pipes, and stopped pipes alone were such a bugbear in the working of the retort-house that anything that could be done to prevent them was well worth attention. Some one had said that he did not see how the make of gas was increased by the adoption of the hydraulic main; but it seemed to him (Mr. Harman) that there was great danger of the make of gas being increased too rapidly.

Mr. Isaac Carr (Widnes) thought Mr. Kendrick had brought the subject before the meeting in a very profitable and interesting manner, and that he had made out a good case, and given very good reasons why they should adopt the wet main in preference to the dry. He (Mr. Carr) had not had any experience with dry mains other than in connection with the tar process they used for increasing their illuminating power at Widnes. There, of course, they had a very powerful plug tap which certainly through its close proximity to the mouthpiece became stopped up at times; but it was so strong in its construction that it could not be injured. These taps had to be taken out occasionally to clear the pitch out of them; but in some retort-house extensions which he had been recently carrying out he had adopted the wet-main principle. There was one point on which he should like to ask Mr. Kendrick a question—that was whether he was troubled with naphthalene, and if he was, whether the change from the wet to the dry main had any effect on it. It had been represented to him that the danger of the naphthalene difficulty was greater with the wet main; and he should be glad to know if Mr. Kendrick could give him any information on this point. Mr. Harman had mentioned the peculiarity of the gas travelling up one side of the retort-house only when apparently, on measuring, the dip seals on each side were as nearly the same as could possibly be; and he might say that he had experienced the same thing. With large retorts there was always this objection; even the direction of the wind he found was sufficient to divert the gas from one side to the other. The gas would take the warmest side; and the particular way in which a current of wind happened to strike a set of ascension-pipes was quite sufficient to make one side take all the draught. His only way of obviating this was to put a mid-feather in the centre of the retorts, and work each retort separately.

The President said he had had no experience with dry mains at Warrington. They at one time employed the anti-dip; but they had had so much trouble due to stoppages, that they gave them up. He had heard from Mr. Paterson that he had practically no trouble with his valves sticking; and, of course, it was a very great advantage if they could have a dip-valve which would not stick. Recently they had put up a wet main; they had all the pipes turned exactly; and yet when they tried to regulate the seal, some of the dip-pipes would blow back while the others were sealed. As far as they could tell, everything was perfectly level. But there was no doubt it was not possible to get the same amount of seal with a wet main as with throttle-valves. A great deal of trouble with throttle-valves arose when used for exhausting. Mr. Paterson, at Cheltenham, exhausted with the Körting jet, and found it work successfully.

Mr. KENDRICK, in reply, said he had never worked with six-hour charges at all—his longest were 4 hours 48 minutes; and for four months out of the time they had them in use they worked the dry mains only. It was unfortunate for them that during a portion of the time they had both an old retort-house in which wet mains had been fixed, and a new house in which there were dry mains; and between the two they had to have a regulating-valve. It was a case of having a man upon the spindles all the time to keep the pressure right. With regard to the make of gas, he found it necessary always to work with 2-10ths or 3-10ths back-pressure, because if he did not do this the proportion of cannel used became a matter of alarm both to himself and his Directors. Coming to the question of the breaking up of the hydrocarbons, these would not break up unless the heats employed were very high; and as with gas made of a low temperature or a high temperature there would always be a certain proportion of hydrogen as well as a certain proportion of the heavy hydrocarbons, of course in the richer gas there would be a greater proportion of the latter. He thought, therefore, he was perfectly correct when he said that with back-pressure in the retort the diffusion of gas itself through the porous material of the retort would be greater than when there was a slight pressure in the retort with a level gauge, or when working with a vacuum, as one gentleman with whom he had been in communication said he did. If one worked with a vacuum, some of the gas from the furnace would be drawn in, and thereby reduce the illuminating power of the gas. As to the cost of working, he might say that in 1896 their cost for coal only was 14d. per 1000 cubic feet of gas made—that was without taking anything off for residuals; and in 1897 it was 13d. although the prices which they paid for coal were rather heavier per ton in 1897 than in 1896. So that there was sufficient ground for saying that he obtained better results with wet mains than with dry ones. In reply to Mr. Harman, he could not give any particulars as to the actual temperature of the dry mains; but he did know the temperature of the condensers. The temperature of the inlet of the condenser working with a dry main averaged from 170° up to 180° Fahr.; in the corresponding period, with the wet main, the temperature was something like 30° or 40° lower. So that the high temperature of the gas coming away when working with wing-valves and dry mains had a good deal to do with the pitching up of the apparatus. With regard to stopped pipes, he must say that with wet mains he had very little trouble indeed. Occasionally they had one or two a week. He told his stokers to try with the clearing-rod every time they opened a mouthpiece; and they generally found the obstruction at the bottom, by the mouthpiece. They had not to leave off working a retort once within the last month on account of a pipe being pitched up. They were not at all troubled with naphthalene in the district, and very little in the works. He must say he did see more of it when working with dry mains than when working with wet ones; but the difference was so slight as to be hardly worth mentioning. He could quite bear out what had been said with reference to the effect of the wind playing upon the retorts. His own retorts were throughs; and it was very frequently the case that the gas was passing up one side one day and up the other side the next. In conclusion, he thanked the members for their kind attention to his paper.

Mr. H. TOWNSEND (Wakefield) then read a paper entitled

EMERGENCIES.

Although the papers which have been read before this and kindred societies have been so numerous, I do not remember any on the above subject, though I can conceive of no topic likely to lead to a better discussion, or one which should prove more useful to young managers of small gas-works, with whom emergencies are the most likely to occur, and who at such times have to rely almost entirely on their own resources. In the hope that the recital of my own experiences may induce other members of the Institution to favour us with an account of theirs, I venture, with diffidence, to place it before you.

As it has been my lot to manage some gas-works which have been badly designed and constructed, and ill-equipped for the work they have had to do, they have naturally been fertile in emergencies. The first of any moment which occurred to me took place more than twenty years ago, when I was in charge of works supplying two small towns with gas. The works were situated in one of these towns; and a quarter-of-a-mile away was a gasholder, which was the only means of supplying the other town. On the same site were also situated the offices of the

Company and two residences, one for the manager and the other for the foreman.

After I had been in charge of these works for a few months, one Saturday night in January, about nine o'clock, with a gale of wind blowing, accompanied by torrents of rain, while busily engaged wrestling with the balance-sheet, I was startled by hearing a most peculiar noise, which seemed to come from the gasholder. I ran round to see what was the matter, when I was thunderstruck to find the holder slowly turning over, and the columns and girders tumbling all over the place. I had instinctively grasped the key of one of the valves, and wondered what was the best thing to do. If the gas continued to leave the holder, it would probably collapse. There were no other means of keeping the town supplied with gas; and if the holder were wrecked, weeks would elapse before it could be again rendered serviceable. So, whatever the consequences, I thought I must do my level best to try and save the bell from further damage. With this thought, I tried the inlet-valve, and found it closed. I opened it, and then grasped the key of the outlet-valve, which I shut. The effect was magical. Out went all the lamps; and people came streaming into the yard to see what was amiss. I soon found myself surrounded by a noisy excited crowd. Among them, however, were some of our own men, and a builder who lived opposite, and who proved very useful. He kindly offered me anything in his yard which might be of service.

Leaving the crowd in charge of the builder, I went round the holder to see the extent of the damage. I soon found a bad escape; gas was roaring out of a great hole in the side. I promptly decided that this hole must be got under water; so I went back to the builder, and he sent men across for some planks, as we found the bottom curb had caught in the brickwork. When we got it clear, the holder sank till the great hole was below the water; and then we breathed more freely. At this point, I think I had better describe the holder. It was a second-hand affair, which the Company had picked up cheap, and was the flimsiest thing I ever saw. It worked in a brick tank which by-the-bye leaked; the water in it never being within 4 feet of the coping. It was only a single-lift holder, 80 feet in diameter; and the crown had no support whatever. It was not trussed; nor was there any timber framing in the tank. The bottom guide-rollers had also been dispensed with. The columns were small round cast-iron ones, about 20 feet higher than was necessary; and the girders consisted simply of T-irons, bolted to the tops of the columns. When the holder was constructed, it was found so light, through taking out the crown trussing, that it would not give sufficient pressure to supply the district. Great slabs of concrete were therefore ranged all round the crown.

Well, after getting the big hole under water, the holder was eleven sheets high above the coping on the windward side, and three sheets on the leeward side. I therefore decided not to let the leeward side sink any more, and strutted up the guide-carriages with short planks. Then we extemporized Spanish windlasses, with chains from the builder's yard, from the bases of the broken columns to the windward guide-carriages, to keep the windward side in its place. The next step was to get the slabs of concrete off the top. I called on one of our men to get up and remove them, but was staggered with his reply: "Well, maister, I'm a married man. P'raps some o' these 'ere single chaps won't mind." But I could not find a single man among the crowd. Well, I thought to myself, "I'm single anyhow"—I was then—"so here goes." I mounted the ladder the builder had brought, and stepped on to the holder. Down I fell, and rolled over and over until stopped by one of the concrete slabs. After pulling myself together, I pushed this off with my feet, and went on to the next, and the next; the darkness, the rain, the wind, and the tremendous angle of the top of the holder, making it a delicious task. There was an awful smell of gas up there, too; and I expected every minute to pop into eternity through a hole in the crown. I shall never forget how surprised I felt to find myself back to the ladder again, and still in the land of the living, after going the whole way round in a sitting position.

We went on all night, getting the bottom curb free from the tank wall, and trying to get the holder into a bit better shape, extemporizing chafing-plates for the curb to work on, by fastening lengths of flat iron on to the edges of planks, and lowering them into the tank. When daylight appeared, we were fortunately able to borrow a number of light chain-blocks from a neighbouring factory. These we fixed on the windward guide-carriages in place of the chains, and decided, when night came on, to try and get the holder to float level by supplying the town with gas out of it. While engaged with these preparations, first one and then another came during the afternoon to know whether they could hold the evening service in the churches and chapels; and thinking I could manage it, I said "Yes!"

After they were gone, and I had time to reflect, I felt very uncomfortable; for if my plan did not answer, and the lights went out, panic would probably ensue, with lamentable results.

However, there was then no time to alter matters; so when it got dark I opened the outlet-valve and put on the pressure with the governor. All this time I had had the inlet-valve slightly open—just enough to keep the holder stationary. I then placed a man at each of the chain-blocks, and shut the inlet. When the pressure came down, I got these men to haul away at the blocks; and so we went on. I had made up my mind to shut the outlet-valve if the pressure got below 5-10ths, and several times it got down to 6-10ths; but hauling on the blocks fortunately always liberated it. The holder was gradually getting into shape as the gas worked out; for the leeward side was still strutted up with the short planks, and all the gas which was being consumed consequently lowered the windward side only. The anxiety was terrible. I never remember such a long night as it seemed. At last eleven o'clock came round; and we had the satisfaction of seeing the holder three sheets high all round, while the town had had its necessary supply of gas. Next day, we borrowed some more chain-blocks, and worked the holder in this way for three months while new framing was fixed.

My next emergency was of quite a different character. We were substituting an 8-inch main for a 4-inch one in the before-mentioned town; and I went up in the evening to see how the men were getting on. I found that the foreman, in his anxiety to make a good show, had undertaken too much; and dusk had come upon him with several joints still to make. He and his men were doing their best under the circumstances; but as I looked along the trench, I noticed one man lying face downwards over one of the joints. I got hold of him; and found he was quite unconscious, and badly gassed. I dragged him out of the trench; and not knowing what to do for the best, it struck me that the treatment for recovering persons from drowning ought to answer, for if it removed water from the lungs it ought to remove gas. Laying him on his back, I opened his mouth, and drew his tongue forward, and then alternately pulled his arms out beyond his head, and rammed his elbows into his ribs. Each time I did this, great gusts of gas came from his mouth; but in about ten minutes, he showed signs of returning consciousness, and was soon afterwards sufficiently recovered to be taken home.

There was an old dilapidated sulphate plant on these works; and I thought that I might just as well try and make it work. This led to my next emergency. There were a number of carboys of acid, which had been there some years; and one day after we had got the plant going, the foreman and myself were carrying one of these carboys to the saturator, when it burst all over us. Singing out to the foreman to follow me, I ran to a gasholder tank and lowered myself into it, up to my armpits. He did the same. The alkaline water in the tank completely neutralized the acid; and neither he nor I suffered the slightest injury. We then set off home, which, as I have said before, was about a quarter-of-a-mile from the works. Our clothes (which had turned quite red), kept dropping off bit by bit, until at last both he and I had to make a bolt for it. We were getting rather too lightly clad for a civilized country.

These works were flooded once, while I was in charge of them. The water rose high enough to put out all the fires and fill the tar-well; but it fortunately kept out of the mains, and so did not interrupt the supply of gas to the district.

After leaving the above works, I was next in charge of one of the stations in a large manufacturing town. This was a fairly-well equipped works. One thing about it, however, caused me much anxiety. The top of the tar-well formed the coke yard; and I was in constant fear that the red-hot coke would one day ignite the vapours in the well. That this was no groundless fear was shown at another works in the same town, where a similar arrangement had been followed. A disastrous explosion occurred in the tar-well a few years since, causing loss of life, and laying the works idle for some months. An explosion also occurred not long ago at another works, where red-hot coke was tipped on the top of a tar-well. Tar-wells ought to be placed out of the way of fire or light in any shape.

My first emergency at these works occurred quite suddenly one afternoon. Everything appeared all right one minute; and the next the retort-lids began to smoke all over the place. Then they broke into flames; and it was evident something serious was amiss. I examined all the pressure-gauges to find out what the trouble was. And here let me say that I think one cannot well have too many pressure-gauges. I like to have one fixed on the inlet and outlet of every piece of apparatus on the works, from retort-house to gasholder. Then, if anything goes wrong, it is not usually difficult to locate the place. Well, all the gauges showed a great amount of pressure; the water being blown out of most of them. It was apparent, therefore, that the trouble was at the holders; and on dipping the inlets, a lot of water was found in each. It took a couple of hours to remove the obstruction. While this was being done, the gas was blowing away at the weakest place, which I was startled to find was the sealing-box of the condensers, which was within a few feet of the boiler fires. Being apprehensive of an explosion, I had the plugs of some of the purifiers removed, and let the gas blow away there, where it could do no harm. It is well in every works, however, to plan the place with the lightest seal where there is least cause for expecting danger; as if a stoppage occurs in the middle of the night, much harm might be done before the trouble was detected. In this particular instance, the mischief was caused by the foreman putting water in the station meters, and omitting to close the taps; the water finding its way through the bye-pass sealing-boxes into the inlets of the holders.

The next emergency at these works was caused by a heavy fall of snow, 18 inches deep, in one night. Fearing some danger to the holders, I turned out next morning at 5.30, and made my way to the works. Tramways were laid along the road I had to traverse; and the tramway people had liberally sprinkled their metals with salt. This, together with a thaw which had set in, had converted the snow into a freezing mixture, about 6 inches deep; and hundreds of factory girls were going to their work through this awful stuff, which was clean over the tops of their wooden clogs. No doubt this is a digression; but it shows what women workers in manufacturing towns have to put up with. When I got to the works, I told off a gang of men to get on to the holders and sweep off the snow. There were no hand-rails to these holders, only a ring fixed in the centre of the crown; and I told each man to make himself fast by a rope to this ring. It was well I did so, for one of the men slipped right off the crown, and hung dangling from the rope over the side of the holder. He looked so irresistibly funny, kicking about in the air with the broom in his hand, that it was some time before the men could overcome their mirth sufficiently to help him; but at last they dragged him up again to the top of the holder, none the worse for his adventure. As showing that there is real danger from snow, one of the holders at another works in the same town, from which the snow had not been removed in time, was completely wrecked on this occasion; the weight of snow on one side causing the columns and girders to give way.

I next had charge of a corporation works, well designed and equipped, and do not remember any emergencies in connection with the works themselves; but one or two occurred in the district. One Sunday night, some excited people came to say there was a very bad escape of gas in their houses. When I arrived, I found nine houses filled with a dangerous mixture of gas and air, and a big fire burning in each. I bundled all the people into the street, much to their disgust, and opened all the doors and windows; and then extinguished the fires with buckets of water. On opening the ground, we found a fractured main. It was a very narrow escape.

The next was caused by the operations of another department of the Corporation. For some inscrutable reason, the gas-main, 18 inches in diameter, in the chief street had been laid many years before 15 feet deep; and then when the sewer came to be built this main was right in the way. To get over the difficulty, the sewer had been syphoned out of the way of the gas-main; and this had caused fevers, and an endless amount of sickness. When re-paving the street, after all the setts had been removed and the ground dug up, the Committee suddenly remembered this weak place in the sewer, and called on me to get the gas-main out of the way. There was only one course out of the difficulty, as the main was so deep, and that was to syphon the main out of the way of the sewer. I had therefore to get four 18-inch square bends and an 18-inch syphon; and as there was a 12-inch branch on one side and an 8-inch one on the other, two suitable tees were also necessary. There was no time to get anything made; consequently, I had to use what I could find, and with a gas-bend from one town and a water-bend from another had to tackle the job. It took a lot of chisel work to pare some of the spigots down; but at last we got them to go together, and the next Sunday we started at three o'clock in the morning. Men never worked harder than did ours that day; but what with the difficulty with the sewage, which was running all the time, night came on and the work was unfinished, and I found it necessary to trust to the gas-bags. The anxiety was great; if one of the bags had burst, I really do not know what we should have done. Fortunately they all held fast; and we got the thing together all right next day. But I fervently hope never to have such a job again.

Since then I have often found the day too short to make necessary connections, when carrying out some extensions in the works themselves, and have found the following a capital way out of such a difficulty: Suppose we are trying to make 24-inch connections, and have not time to finish. This work is generally done in the summer, when a smaller pipe would suffice for the gas we are making. Take a piece of (say) 8-inch pipe; put an end into each of the 24-inch pipes which there is not time to couple together with 24-inch connections; and then fill up the space all round the 8-inch pipe with brickwork in portland cement, and when finished render the face with neat cement. This will soon set and make a gas-tight joint, and it can be easily removed the next morning. If the time is very short, mix the cement with hot water, and it will set more quickly; and if some soda is put into the hot water, more quickly still.

My first emergency at the next works of which I was in charge happened as follows: I was called out of bed one night, and when I got into the works every retort lid was blazing; while such dense volumes of smoke poured out of the retort-houses that it was difficult to see one's way about. Fortunately, everyone was asleep at the time, or we should have had the fire-engines and a crowd of people. All the pressure-gauges were in a troubled state. The three retort-houses all discharged into an underground foul main, from which the tar, &c., drained off to the tar-well. It struck me at once that this main was water-logged, through the tar-well being too full; but on setting a man to examine the tar-well, I was rather nonplussed to hear it was all right. I tried everywhere else, but could not find any clue. Explosions were taking place in the hydraulic mains, with reports like distant thunder; and the mouthpieces and ascension-pipes were getting red hot. We therefore went back to the tar-well; and, on examining it again carefully, we found that the man had made a mistake in his excitement, and the well was full to the brim (it was a ridiculously small well, by-the-bye). It took us a couple of hours to get the surplus water out; and on hunting for the cause we found that a man who had been set to run some water into the hydraulic main in one of the retort-houses, to restore the seal, had not shut the tap off, and it being connected to the water-mains the tar-well had got flooded out. Of course, I had the connection removed after this, and would never again have hydraulic mains coupled up to water-mains. The best plan is to connect to an overhead liquor tank; it is then impossible to flood the tar-well.

Another emergency was caused by a blizzard. A hurricane blew all one night, accompanied by very fine snow, blocking all the roads and railways, and cutting off the town's water supply, which passed through an open channel, for some distance from its source. For nearly a week, we were cut off from the rest of the world. We could get no coal into the works, and no coke out. We ran short of lime for purifying, and had to put down the sulphate plant for want of acid. But the greatest difficulty was with the coke. We used all the snow up to quench it, and took all the water we could from the gasholder tanks: but one night the coke yards were all on fire, and it was with the greatest difficulty we saved the works from destruction. That was a week none of us is ever likely to forget.

At another time we had the coals on fire in all the stores simultaneously. It was necessary to get a good stock of sea-borne coal in during the summer; and every winter this coal fired through spontaneous combustion. We found nothing was of any use but using the coal up. Playing on it with water, or even with ammoniacal liquor, simply drove the fire farther in, and caused it to break out afresh.

Another emergency was caused by the pig-headed stupidity of one who ought to have known better, which resulted in all the holders being emptied about nine o'clock one night; there being nothing after that hour but the make. All the holders were aground save one, and that was only just afloat; one rivet only being above water. I was fearful, if this holder also got aground, that the governors supplying the high-level districts would collapse; so for 2½ hours we had to fight to keep this one rivet above water. That the draught of gas in a high-level district will cause a governor to collapse, was proved when one of these districts was first supplied with gas; when the inlet valve being accidentally shut, the governor collapsed, and was wrecked.

Another emergency was caused by a holder to which a third lift had been added on Gadd's principle. This system is excellent in itself; but in this particular holder there was such a lot of play at the bottom guide-rollers of both the old lifts, that the holder had a knack of getting out of level a good bit, and one day I was alarmed to find one of the cups was unsealed, and gas was pouring out of the holder. With much difficulty, we got the cup sealed again, and afterwards adopted measures to prevent a similar occurrence. But it brought it home to me pretty forcibly that it is not wise to add an additional lift to an old holder, and send it up above the framing, unless each lift of the old holder is rigidly guided by its bottom rollers.

A fruitful source of stoppages, in my experience, has been the ridiculously small pockets some makers put in their station meters, to act as outlets. These get choked with naphthalene, and are very difficult to deal with, as they can only be cleaned out by taking some of the top plates off the meter. If manufacturers would only make this pocket more commodious, they would relieve managers of a considerable amount of anxiety.

Favourite places for the deposition of naphthalene, as I dare say most of us have found out, are the outlets from the washer and the station meter, as the gas is brought into sudden contact with cold water at these points; and I have found it very desirable to have plenty of manholes on the mains leading from the washer and the station meter. Then choked pipes can be thoroughly cleaned out in the summer. For want of these I have had to remove pieces from the mains, and extemporize manholes many times—in fact, I have never had charge of a works where there were adequate means for getting at, and cleaning out, blocked underground pipes. Sometimes it is impossible to throw choked pipes out of action in the depth of winter; and then a good way to get a passage through them is to steam them. If a liberal quantity of naphtha is added to the feed water of the boiler, the naphthalized vapour will very quickly melt the naphthalene; and it can then be pumped on to the syphons. Of course, care must be exercised in the steaming operations, or damage may be caused to the apparatus.

The faces of purifier centre-valves getting out-of-true have at various times caused me much uneasiness. The best thing to do is to throw the valve and purifiers out of action, and scrape the faces until they are true again. But it often happens that purifiers cannot be spared; and then some other course must be adopted. I have found a good plan is to pour a liberal amount of pure sperm oil on to the faces of the valve, before and after changing. I remember once, when the test-papers were quite black at the station meters, and it was impossible to do anything else, the liberal use of sperm oil pulled us through the winter, without anyone suspecting the dilemma we were in. Large centre-valves often get out-of-true through the different temperatures caused by the process of purification in the boxes themselves; variations in temperature causing different degrees of expansion in the metal. This makes large centre-valves objectionable.

The cups of holders being too shallow have sometimes caused me considerable anxiety. The seal can be increased by bolting angle-irons all round on top of the lute. These can be of any desired depth. I have known the seal to be increased 4 inches in this manner. It is always best, when designing apparatus, to make all cups, whether of gasholders, purifiers, or other plant, of ample depth. There is then a margin to work on in times of difficulty.

The overheating of the material in purifiers has been another source of trouble. I have found that purifiers in which the material has got dangerously heated can be cooled down by rigidly excluding every particle of oxygen or air from the gas which is passing through them.

When getting a holder into action after repairs, considerable care is necessary, as there will be a certain amount of air in the crown; and I have found a good plan to get it out is to lower a tube through a hole in the crown, until it is but a few inches from the surface of the water, as all the air will accumulate there and can be removed in this manner. Before turning gas from such a holder into the district, it is well to run a few sheets of gas into it from another heavier holder, through both inlet and outlet; as any air which may be left in the holder will settle in these pipes, and might cause trouble if sent out undiluted.

Discussion.

The PRESIDENT said they had had a very interesting as well as amusing paper from Mr. Townsend; and a great deal of real knowledge and information was to be derived from it. He should be pleased to hear the experiences of other members in getting over their emergencies.

Mr. R. G. SHADBOLT (Grantham) said that, if they were all to relate their various experiences in the way Mr. Townsend had done, they would be there for a twelvemonth. He had expected something humorous, and of practical value; and he had not been disappointed. Without attempting to relate all his own experiences, which he should be sorry to do, he must refer to one little incident that occurred to him, because of its similarity to one of Mr. Townsend's experiences. It was with respect to the bursting of a carboy of vitriol. One severe winter, the water seemed to have separated out from the acid, and become a solid block of ice in the bottom of the carboys. They were using a direct-fire still, and had the carboys ranged round the top of the still to thaw. On picking up one of the carboys, it collapsed, and saturated him and a labourer with vitriol. They had a gas-holder tank close at hand, and also a condenser consisting of a few pipes running backwards and forwards about the tank; and they had a water riser, which had been turned off for some considerable time. Believing, as Mr. Townsend had done, that water was the best remedy for them in their condition, they unthinkingly tumbled into a cauldron of nearly boiling water, which they quickly got out of again. He wished to express his best thanks to Mr. Townsend for formulating what had, generally speaking, been the experience of most of them.

Mr. W. NEWBIGGING (Manchester) remarked that a noisy, excitable crowd usually gathered round a gas-works when there was an accident; and he was curious to know whether there was a crowd assembled when Mr. Townsend pushed the slabs of concrete off the top of the holder in the way he had described, and whether any fell among the crowd.

Mr. TOWNSEND said he would relieve Mr. Newbigging's mind at once by saying that this did not happen.

Mr. E. A. HARMAN (Huddersfield) said they were not generally proud of their emergencies; and it was therefore especially plucky of Mr. Townsend to relate so many of his own as he had done. Too frequently they found that the failures had resulted from the neglect of those under them, for whose actions they were to a certain extent indirectly responsible; and therefore Mr. Townsend's paper had been especially instructive. At the last meeting of The Gas Institute, Mr. Stelfox had related the failure he had experienced with the Claus process; and he ventured to think that the history of that gigantic failure was almost as profitable as the experiments. What they learnt from Mr. Townsend's paper was the necessity for doing what the Irishman described as "putting one's foot down with a firm hand," and always seeing that their apparatus was in a proper state of repair.

Mr. TOWNSEND, in reply, said he had a considerable amount of hesitation in bringing forward the paper, because, as had been remarked, they were not proud to confess their failures; but as most of these things had occurred from causes over which he had no control whatever, he felt to a certain extent relieved from any imputation of blame. He had received a note from Mr. Charles Wood, regretting that he would not be able to be present, and in which he said: "I notice two slight inaccuracies in your reference to Bradford. In reference to the Valley Road explosion, this was not caused by hot coke, but by the gases from the well finding their way to the retort-bench through a large crack caused by the settlement of the foundations. The works were only 'laid aside' for 3½ hours, and not for 'several months.' The 18-inch snowstorm you mention certainly did not 'completely wreck' any holder in Bradford. If you mean the Clayton accident, I was not aware that the snow had anything to do with it; but, at any rate, Clayton is not 'in the same town.'" He had not mentioned any names in his paper; but in the cases he had referred to, he had tried to pick out those which conveyed a moral, and which might be of assistance to the members. With regard to what Mr. Wood had said, he must admit that he used too strong an expression when he said that the gasholder was "completely wrecked."

VOTES OF THANKS.

Mr. C. A. CRAVEN (Dewsbury) then proposed a vote of thanks to the readers of the papers. With regard to the first paper, he did not join in the discussion because he had not had any experience with dry mains; but he must say that he thoroughly sympathized with Mr. Kendrick in his experiences. As to Mr. Townsend's paper, which they had appreciated so much, he was sure that it would prove very useful, because it would bring before people a series of experiences to which perhaps they were strangers, and show them how to promptly deal with any emergency that might arise. He could write a large book about his own experiences; and the only way to discuss such a paper as Mr. Townsend's was by telling another story.

Mr. T. B. BALL (Rochdale) had much pleasure in seconding the vote of thanks. As Mr. Craven had very justly remarked, Mr. Townsend's paper could only be discussed by the relation of other experiences, if not similar, at any rate involving the exercise of prompt judgment under severe conditions. There was no doubt that one man's experiences were always useful to another; and for this reason they were indebted to Mr. Townsend for the relation he gave of the steps he took with regard to his emergencies. He could not discuss the question of dry mains, not having had any experience with them; but he had had quite sufficient with wet mains to entirely satisfy him. Though wet mains left much to be desired, he gathered from Mr. Kendrick's paper that there was such a thing as getting out of the frying-pan into the fire in this respect; and, under the circumstances, he preferred to remain in the frying-pan.

Mr. ISAAC CARR (Widnes), in supporting the resolution, said he had intended to compliment Mr. Townsend on his paper, because, while it had been pleasant to listen to, it had been very instructive. A recital of their difficulties and troubles was certainly helpful to others.

The resolution was passed unanimously.

Mr. KENDRICK and Mr. TOWNSEND briefly returned thanks.

A vote of thanks having been accorded to the Committee and Officers of the Institution,

Mr. R. PORTER (Elland) responded on behalf of the Committee.

The business then closed.

The members afterwards partook of high tea, and spent the evening together.

SCOTTISH GAS MANAGERS.

ANNUAL MEETING, APRIL 6.

The Fifteenth Annual "Informal" Meeting of Scottish Gas Managers was held in the North British Station Hotel, Glasgow, under the presidency of Mr. HUBERT POOLEY, of Dunfermline. There was a large attendance of managers and friends, among whom were the President (Mr. Thomas Wilson, of Coatbridge) and office-bearers of the North British Association of Gas Managers, and the Secretary (Mr. W. B. M'Lusky, of Selkirk) of the Waverley Association of Gas Managers.

CHAIRMAN'S ADDRESS.

The CHAIRMAN, in his opening address, said: It was my extreme misfortune to be absent from the annual gathering last year, when you voted me into the chair for the present meeting; and I am exceedingly sorry that my thanks to you should be so late in the day as this. But I must now take the opportunity of thanking you sincerely for the honour you have done me.

These annual gatherings have been kept up more with a view to social intercourse, and to the discussion of current topics of interest, than as providing a means of listening to papers or other communications from members; and it has been a very wise plan for the Chairman on these occasions to introduce a few subjects for the meeting to discuss.

The newer methods for obtaining illuminating gas from coal or other material seem, this year, to have received a considerable share of notice. Many new carburetted water-gas installations have been introduced, and inclined retorts are looked upon with increased favour. About six years ago, Mr. Stelfox introduced water-gas plant at Belfast; and about a year later we were shown the first carburetted water-gas plant north of the Tweed, when we visited the Dawsholm works of the Glasgow Corporation. And now we have in Great Britain installations capable of producing over 69 million cubic feet of water gas per diem, either actually at work or nearing completion.

A few weeks since a very lucid description of the most modern type of sloping retort plant was read before a Birmingham

Engineering Society, and many will have read it with interest.* I had an experience of M. Coze's first system of "slopers" when I was serving my articles; but since those days very great improvements have been introduced, and I think I am correct in stating that to-day, for economy of production, they stand unrivalled.

When I first came North, I was very much surprised to find that the tar and ammoniacal liquor were usually sold together, either per 100 gallons or per ton of the mixture, the liquor being of a fixed minimum strength, as estimated by a Twaddel hydrometer. I think a far more equitable method of transacting business would be to sell the two residuals separately, estimating the percentage strength of the ammonia in the latter by means of distillation tests, and selling on a sliding-scale, according as the sulphate market fluctuates month by month. There would then be a definite basis to work upon, instead of the specific gravity tests, which, as everyone knows, are very misleading. But, probably, with a fair prospect of the sulphate market keeping at a passably remunerative figure, more of us will be tempted to go in for its manufacture; and if we are, I hope we shall remember to whose endeavours the present enhanced values are mainly due, and join the ranks of those who are endeavouring to bring the value of sulphate more prominently forward. In this way, and, I think, in this way alone, can the prices be kept up, and perhaps improved.

We have not heard very much about acetylene lately; and what little we have heard, as a competitor with coal gas, seems to have come exclusively from the Continent, where, I understand, a few small towns have taken up this means of obtaining artificial light. My own experience with acetylene has not been very great. I have made a few experiments with the view of estimating its value as an enricher; and the best results that I obtained placed it at about four times the value of our richest cannels. This would mean that, before we could use it profitably, we should only be able to give from £3 to £3 10s. per ton for the carbide. Of course, I am speaking now of Dunfermline, where we are very well situated for obtaining cheaply some of the richest cannels. My own best results have been obtained in a bicycle lamp; and for this purpose the light is very powerful. Indeed, it is almost too bright for the comfort of those in charge of approaching vehicles, or of pedestrians. I must say I think far too much looseness is observed in the selling of calcium carbide, practically to anybody, notwithstanding the regulations imposed by the Board of Trade. In Mr. Hastings's valuable annual for the current year, we find a very good summary of the views of a conference of German chemists, held in Berlin about twelve months ago, on the chief reasons for danger in the production and use of acetylene.* The opinions then expressed seem to point out as the three principal reasons: (1) Generation under too high a pressure; (2) the formation of copper acetylide; and (3) the use of acetylene containing hydrogen phosphides or hydrogen sulphides, as impurities. We find that very stringent regulations have been enforced in Berlin and Paris, and other places, both regarding the production of acetylene and also the transport of liquid acetylene.

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* This paper will be found in the *Journal of Gas Lighting*, Vol. LXXI., pp. 588, 647.

I have managed to procure a sample of an old horizontal-dial meter, which has been in use in my town for the past 60 years. The meter has been working quite as correctly as any of the modern meters, and has given us, practically, no trouble. There is a very great difference in its appearance to that of the modern wet meter. I have not, as yet, seen any more of the "Positive" meter than a diagram; but the principle of it seems to be a very excellent one, and the meter should combine all the advantages of the dry, with the durability and greater accuracy of the wet meter.

We shall all hail with welcome the advent of a new and much improved incandescent gas-burner, of which we have heard some rumours within the last fortnight. Indeed, intimation has now been given by the Welsbach Incandescent Company that the burners are to be placed on the market in June. We have had two great improvements in the methods of applying illuminating gas; and now we are promised an advance which is certainly as far ahead of the present incandescent burner as it was ahead of the regenerative lamp, or than the regenerative lamp was ahead of the ordinary flat-flame burner. With an efficiency of 34 candles, or thereabouts, per cubic foot (presumably with London 16-candle power gas) the question will soon surely have to be faced: "Is it value to manufacture high-grade gas?" Let us hope that the mantles for the new burner will prove more durable than those now in use. There is still much room for improvement in this direction.

If we would follow the example given elsewhere of describing some of our worst experiences, or the greatest difficulties we have overcome,† it would prove interesting to all; and I am sure that some of us who are the younger members of the profession, and of the Associations, would benefit very much by the experiences of our older brothers in arms. The most trying season I ever went through was spent in the old works of the Dunfermline Gas Company. We had plenty of retort power—78 retorts 8 ft. 6 in. by 15 by 13 inches; and we were producing something like 400,000 cubic feet of gas per diem. Our condensers, too, were quite sufficient; and we had a 500,000 cubic feet per diem Walker's purifying machine. We had two exhausters—one very small, and the other a nominal 40,000 cubic feet per hour one, of an antiquated pattern. In order to pass the largest quantity of gas we were then making, we had to drive our engine at about 200 revolutions per minute; and the noise in the house was simply deafening. However, the exhauster held out well until I had done with it. Our greatest difficulty of all lay in the purifying-house, where we had only four purifiers, each 12 feet by 8 feet. The result of this was that we could not purify our gas thoroughly; and for three or four weeks in the depth of that winter we changed our purifiers at the rate of eight per week. Gasholders, excepting one at the new works, which was then in use, were giving me a great deal of anxiety. I had two which each held 30,000 cubic feet, and one which held 125,000 cubic feet; and I had to keep men constantly employed watching the holders, and patching them as best they could, until we had everything ready for gas making at the new works. The outer shell of the largest holder completely gave out, and narrowly escaped dropping off, when the holder was well up; and on one occasion the man who was patching one of the smaller ones put his thumb right through the shell.

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* See *Journal of Gas Lighting*, Vol. LXIX., p. 645.

† See *ante*, p. 76.

A word might here be said with regard to "gassing." I have three times experienced serious cases of "gassing" among employees; and each time artificial respiration was resorted to successfully. I should much like to hear the experiences of some of those present who have tried the use of oxygen on similar occasions.

I have purposely curtailed my address as far as possible, and trust I have not wearied you by touching on subjects which are nearly all old, but which should be evergreen to all of us. I hope we may have a good talk on some of them—at any rate a good and useful discussion on the difficulties of purification (say, from the retort to the station-meter) should prove interesting, and perhaps would be the most profitable of all the headings touched on.

Discussion.

Mr. W. Smith (Ayr) said they had all listened with the greatest pleasure to the Chairman's address. It contained several points on which he would like to say something. There was certainly great prejudice against water gas, on account of its poisonous nature. They might say that only a certain proportion of water gas was being used; but still that did not remove the prejudice people had against it. In Ayr, he had been repeatedly told by two or three men who had, all their lives through, been engaged in business in Glasgow, and who were now retired and living in Ayr, that if he introduced water gas into the town, they would immediately cut off their gas supply. They could not meet a statement of this kind by saying that there was only a certain proportion of water gas. He thought that as long as they could make coal gas as economically as they were doing at present, which was in some cases cheaper than water gas, they should leave water gas alone. It was right enough in large works to separate the tar and liquor, and to sell them separately; but in small works it would more than duplicate part of their plant, and lead to expense and trouble. When they could sell the two together at a certain price, he thought it simplified matters very much. Until he could see the advisability of separating them, he should continue to do as he was doing, and sell at so much per 100 gallons. He did not know what the advantage was in separating them at the works rather than selling to tar distillers. Acetylene gas certainly gave a very nice light to look at; but when they considered that whenever calcium carbide came into contact with water it became dangerous, they began to think that it was too fine a substance for constant use. It could not stand the "rough and tumble" of every-day work. As far as they had experience, it was very dangerous. He had had two or three experiences of "gassing." Artificial respiration was very good; but the best remedy he had got for "gassing" was a stiff glass of whisky.

Mr. T. Wilson (Coatbridge) was sure they were all indebted to Mr. Pooley for his valuable address. He had given them much good matter for discussion. He (Mr. Wilson) had been making inquiries for some years as to water gas; and he found that it could not compete in a mining district with coal gas. It could not be produced so cheaply, of the same quality; but it suited some towns. There were none of them but would be willing to adopt water gas if they found it as economical to produce as coal gas. It suited Glasgow or Edinburgh, where a sudden demand for gas came on, and a large volume was required;

but he did not think it would suit the smaller towns. It was of little moment to them whether they sold their tar and liquor combined or separate—it was a matter of money only. It was for the gas manager to say which was best. If he found it more profitable to sell them combined, he should do it. They had a good example in Mr. Ewing, who sold them combined; and he would like to hear his experience in the matter.

Mr. W. Ewing (Hamilton) said that the highest return he ever got for residuals, including coke, was 6s. 8½d. per ton of coal carbonized; but he could not get that now. At the present time he was selling tar and liquor at 3s. per 100 gallons, which would make the return for coke, tar, and liquor about 3s. 6½d. per ton of coal. He supposed that in most works it was better to utilize the tar and liquor, so far as they could, in making sulphate of ammonia. They anticipated going in for sulphate plant, on account of the great trouble they had had in the storage of tar and liquor. He had been speaking to Mr. Carlow that morning about his plant; and, to all appearances, he thought it would be better, considering the low prices prevailing at the present time, for each gas manager to go in for the manufacture of sulphate, and sell the tar either in the green state or in the shape of pitch. He had never had, in all his experience, a single case of "gassing" among his workmen; but one of their councillors had been reading something in connection with an accident in England, and brought the matter before the Town Council. The conclusion come to there was that it would be a safe thing to have a cylinder of oxygen kept at the gas-works, to be used in cases of "gassing." Fortunately, he had never had occasion to use anything of the kind.

Mr. Wilson said that at Coatbridge he got something like 4s. 3d. per ton of coal for his residuals—coke included. He thought that in a works manufacturing as much as 50 million cubic feet of gas per annum, it was expedient that they should work up their tar and liquor.

Mr. R. S. Carlow (Arbroath) said that when he went North he found he had the greatest difficulty in getting the residual products disposed of; it did not matter whether the tar and liquor were combined or separate. They sold both ways. He began to consider the matter, and succeeded in demonstrating that they would do far better to manufacture the residual products themselves. He would give them some figures. In the month of February last they sold a considerable quantity of sulphate at £9 10s. per ton. That would produce a very good revenue this year. They also sold, in the month of February, naphtha at 11d. per gallon. After taking out the naphtha, they sold the boiled tar at 1s. 1¼d. per gallon. He got for the boiled tar as much as he would have got for the whole of the unmanufactured products; and he had all the rest as profit. This showed that Mr. Wilson was very safe in making the statement that he would advise gas companies and corporations who had an output of 50 millions to work up their residuals. He would go down further, and say that those with an output of only 20 millions should do so. They would make—although he did not want to put a figure upon it—at least 5 per cent. more than they would by selling the residuals, he did not care whether mixed or separate. The first case of "gassing" he saw was when he was a boy in Linlithgow. A workman was making a joint on a 4-inch main; and the gas got so much the better of him that he became unconscious. His (Mr. Carlow's) father administered to him a glass of whisky in a bottle of ginger beer. It relieved him; and the man came to himself at once.

Mr. A. WADDELL (Broughty Ferry) said that in his last place he worked up sulphate of ammonia, and found it very profitable. He gained something like 1s. per ton of coal carbonized. He had lately been thinking it would be advisable for them to do the same in Broughty Ferry. Just a little caution might, in the meantime, be exercised. He had very little doubt about the advantage of taking the naphtha out of the tar; but he would be very pleased to hear what were the experiences of those who did it, as he was afraid the trouble might be so great that it would be hardly worth the doing. However, from inquiries he had made, he found the opinion to be certainly in favour of making sulphate of ammonia. Mr. Pooley had mentioned sloping retorts. Not many of them, he supposed, had had experience with them; but they were all anxious to learn what were the facts o the case, for and against them.

Mr. J. W. CARMICHAEL (Barrhead) was sure Mr. Pooley had given them many subjects to think upon; and some of them such as those who were in smaller works might not very well entertain—water gas or inclined retorts. Water gas was all a matter of price; and the time might come when they would have to consider it. He thought it was the right thing to have good-sized purifiers. Last year he put in a set, 14 feet square; and his mind had been at ease ever since. He did not know how they would have got through their work last winter except for them. He had had a few cases of "gassing," and he had always tried brandy as a cure. He saw that Mr. O'Connor advised milk; and there might be something in that.

Mr. A. Wilson (Dawsholm) said they had had a little experience in Glasgow with water gas, but had discontinued it in the meantime, as they found that they could make good coal gas rather cheaper. But still water gas had many advantages to recommend it which other systems did not have. It was easily and quickly made; and certainly one great point about it was that it used up a good deal of surplus coke, for which it was sometimes difficult to find a market. He thought the poisonousness of water gas was merely a question of degree, and did not enter into the question of the supply of the gas where it was profitable. The carbonic oxide was only increased by a very small percentage. If one turned on a burner of the gas at night, and left it on, he did not think it would matter very much in the morning whether the gas had contained a percentage of water gas or had been coal gas alone. The accidents which had happened in districts where water gas was supplied he did not think had ever been traced to water gas. They had not had very much experience in the North with sloping retorts; but it appeared to him that, with their charging machinery, they could hold their own with "slopers." In some places where they had machinery and slopers together, it was a "toss-up" which was best. It might be supposed that inclined retorts would give better returns; but, so far, they did not seem to do so, or they would not have so many companies and corporations going in for machinery. If slopers were so economical, they would adopt them instead. He could say very little about tar and liquor. At Glasgow, they sold them together at so much per ton, according to the market. They had too much to do in making gas to go in for the working up of their residuals. Where managers could afford to give their attention to the working up of tar and liquor, they would save the expenses of a tar-works, and would gain a little in this way. Since he came North he had not had any experience in the "gassing" of workmen. In the South they had many cases; and they found that lemonade, ginger beer, or milk, was preferable to either whisky or brandy, as a cure.

Mr. T. Wilson, referring to Mr. Waddell's request for experience in the working up of residuals, said he had gone into the figures pretty minutely; and he found that, supposing everything were favourable, for naphtha, pitch oil, and pitch, they would have a gain of 3d. per ton of coal carbonized.

Mr. T. Lighbody (Renfrew) enquired what was the actual return per ton of coal for sulphate of ammonia, and distilling the tar and liquor, exclusive of coke. What he wanted to know was whether it would be more profitable to sell or manufacture into sulphate.

Mr. T. WILSON said that in Coatbridge they had a yield of 6½d. per 1000 cubic feet of gas, or about 4s. 2d. per ton of coal, including coke. Unfortunately, he used a very cheap class of coal. The output was something like 8000 cubic feet per ton; and the average cost was 7s. 3d. He, however, never got less than 4s. or 4s. 3d. per ton for residuals, including coke. He found that they had as much profit in the manufacture of sulphate as they had from the tar. That was 3d.; and if they added the other 3d., it made 6d. which they would have instead of selling "green." Of course, circumstances altered cases; if they were near a tar distiller, they could command a better price. The figures he had given they were to take as relating to Coatbridge alone, and not to any other town.

Mr. CARLOW said that, so far as he was concerned, if he were selling his raw material, either mixed or separated, he would be getting, at present, from £370 to £400 a year from tar distillers. On the other hand, he was manufacturing and selling naphtha, boiled tar, and sulphate of ammonia; and he was getting—after paying all expenses, capital, wages, and everything—more than £1000. He had thus a profit of £600 or £700 on an output of 60 million cubic feet of gas.

Mr. W. B. M'LUSKY (Selkirk) said that when he was in Kelso, with a make of 13 millions, he received from £180 to £190 for tar and liquor alone. They carbonized about 1400 tons of coal. As to sulphate, they were situated so far from the tar distillers that the question of carriage entered into their contract. He believed that in a district like that around Kelso it would be profitable if one gas-works were to start a plant for working up residuals and the others were to send in their raw material to it. But he did not at all see that in a place like Selkirk it would be profitable to attempt to compete with the distiller. With regard to water gas, he might draw the attention of those present to the remarks which Mr. Foulis made to an interviewer not long ago. He said that water gas was useless in a fog, because the fog would often be away before the water-gas plant could be set in operation. It appeared that water-gas plant could not be brought into operation in two or three hours, as appeared in advertisements; and Mr. Foulis stated that it would be better to have recourse to holders of larger size, and then a stock of gas would always be at hand. Another point with regard to water gas was that the carbon monoxide in it acted so rapidly on the blood.

Mr. **Forbes Waddell** (Forfar) said there was one thing he was not satisfied with. He got for tar and liquor, per ton of coal, 2s. 3d. from the tar distiller. They were thinking of erecting sulphate plant; but the question was whether, considering the price they were at present receiving, it would pay them. He had not gathered from the replies whether it would really be profitable or not. He would like those who were working up residuals to give their figures as to the quantity of sulphate they obtained per ton, leaving out the coke. As to purifiers (he might say that they used a good deal of shale), he put in a set of three, 18 feet square by 6 feet deep. They had a make of over 30 million cubic feet. They changed one purifier in the middle of December last, and they had not changed any others till the previous day. They used oxide in one box; and it stayed, as a rule, about a year in the purifier.

Mr. P. B. **Watson** (Falkirk) asked if Mr. Waddell found any difference in the illuminating power of the gas, from the same class of coal, when using oxide, from what he did when he was using lime.

Mr. **Waddell** replied that he took the precaution to analyze the gas, in a simple way, with a Bunte burette, so as to ascertain whether or not there was any carbonic acid passing through the lime. They would not expect to get any difference in the illuminating power unless they removed all the carbonic acid. The gas was passed first through one lime purifier. In this way they got the lime fouled; and the purifier was kept on for about a fortnight. Then he changed, and put the gas through the oxide first. He always had a lime purifier last. The gas was tested by a public tester; and it did not vary very much—from one to two candles, as a rule.

Mr. W. **Mackie** (Port Glasgow) asked if he understood Mr. Waddell to say that he used a lime purifier after his purifying was finished with oxide.

Mr. **Waddell** said the second and third purifiers were charged with lime. He could work through 3, 1, 2, or 2, 3, 1, or 1, 2, 3; but, as a rule, it was 1, 2, 3. When they were changing, it was a matter of putting off (say) No. 3, and working Nos. 1 and 2. They changed whenever they got carbonic acid passing the clean lime. Last year, over all, lime and oxide cost £35 for a make of 33½ million cubic feet of gas. They had their oxide on the hire system.

Mr. T. **Wilson** pointed out that after eight days the lime in the last purifier would exist as carbonate of lime, and would have no affinity for carbonic acid.

Mr. **Waddell** said that when the gas went through the oxide at first it did not commence to purify the gas efficiently at all. He had a great deal of trouble with this matter last year. When he put on the lime purifier first he did not wait till it became fouled, but till it got heated up a little; and it certainly did its work a great deal better. After that he did not believe in passing the sulphur forward into the lime; and it took it all out in the oxide purifier—leaving the lime to take out the carbonic acid. If all the boxes were filled with lime, and all clean, he would expect to get sulphur passing the purifiers more readily than if one of them had been in action about a fortnight. Their make was at the rate of about 8000 cubic feet of gas per hour.

Mr. T. **Wilson** thought that Mr. Waddell was to be complimented on his results, whether it was due to his working oxide in conjunction with lime, or the coal he was using. But his cost was certainly very low. His material only cost him ¼d. per 1000 cubic feet of gas sold. At Coatbridge, it cost ½d. per 1000 cubic feet. He did not use oxide at Coatbridge. He found that it fired by spontaneous combustion; and they had several times had explosions. At Coatbridge, they used something like 33 per cent. of shale; and gas from shale was much worse to purify than gas from ordinary coal. However, he found that some splints were quite as bad to purify.

Mr. **Waddell** said that at times he used about 30 per cent. of Fife shale.

Mr. T. **Wilson** remarked that his experience with Fife shale was that it was not so bad to purify as some others.

Mr. **Mackie** said he never had any explosion with oxide; and if he had room in his works to store both lime and oxide, he would use them both.

Mr. D. M. **Nelson** (Glasgow) did not think that any explosion would take place with oxide without his knowing it; and he would like facts on the subject.

Mr. T. **Wilson** replied that he had not only had explosions in oxide boxes, but had seen lime grids fired.

Mr. **Carlow** said he had tried both substances, and in all ways possible—the lime before the oxide, the oxide before the lime; and he said this—that, in the use of oxide, the "game was not worth the candle." In lime they had an agent on which they could depend; it took out both the carbonic acid and the sulphuretted hydrogen thoroughly. Whatever gain they might have in cost by using oxide, they lost in illuminating power, on account of carbonic acid. With lime they could use cheaper coal, and still keep up the illuminating power.

Mr. J. M'Gilchrist (Dumbarton) agreed with Mr. T. Wilson that Mr. Waddell must be complimented upon the wonderful results he had obtained in regard to the cost of purification. The subject which had taken up the largest amount of discussion was with reference to residual products; and while the general opinion had been that to manufacture sulphate from the liquor, and perhaps naphtha from the tar, there could be a good word said for the old-fashioned method, which had been carried on in Scotland for a long time, of selling the tar and liquor at a price per 100 gallons. Perhaps as Mr. Wilson, of Dawsholm, had remarked, a price per ton of coal carbonized might be a simpler way. If, with all the skill of the esteemed President of the North British Association, only 6d. of profit per ton of coal carbonized could be produced in the working up of residuals, on a yield of 8000 cubic feet per ton, the return was less than 1d. per 1000 cubic feet. Managers of gas-works had a hundred-and-one duties to perform. If there were added the scientific knowledge which was required for the production of these products economically, he was afraid something else would be going to waste. It was not wise, at the present time, to add to the gas manager's duties. These were well defined; and if they were attended to, he thought it would be more in the interest of gas consumers than would be the introduction of the new business of manufacturing sulphate, especially in small works. They must remember, in taking the figures adduced by Mr. Wilson and Mr. Carlow, that the latter gentleman lived far from tar distillers, and possibly the price he received for his tar and liquor showed badly as against what was got by managers who were nearer. Tar distillers would be wise to give a fair price for tar and liquor, otherwise they would be having all the owners of gas-works introducing this new plant. In Glasgow, where there was a large manufacture of gas, they saw that they could do better by selling their tar and liquor than by working them up. Notwithstanding anything that had been said in the discussion, he would not change from the old method of selling per 100 gallons at the highest price he could secure. Most of the gas-works he was acquainted with were small; and if this new process were added, the plant would occupy space which might be utilized in a better way, in connection with gas manufacture. He was very pleased to hold to the good old plan.

Mr. Carlow: If I had got a good price, I would have held to it too.

Mr. M'Gilchrist said, with regard to water gas, he thought that to most of those present at the meeting it could not be a question which was within the region of practical politics. Till they could make water gas very much cheaper than coal gas, it would, with all the risks attending it, be unwise to adopt it. He had had a great many workpeople gassed. He could tell them that fashionable doctors in the West-end of Glasgow, when called to men who were gassed, knew nothing about what to do; and he had had to assist them. He should say ginger beer would be better than either whisky or brandy as a cure. Possibly, in Scotland, they were not ripe for inclined retorts. In England, where they used stuff like dross, perhaps the angle of repose was easier found than it would be were they charged with cannel coal. He was afraid that the round cannel would have an inclination to move to the bottom mouthpiece, and possibly the gas would not be very well taken off. In any case, they had not had any experience in Scotland with inclined retorts; and they could say little about them. He saw one or two meter manufacturers present, and he would be glad if they could explain how it was that the old meter before them had stood the test of 60 years' working, and was as good to-day as ever. They had changed the system of manufacturing meters without producing any improvement.

Mr. A. YUILL (Alloa) thought they would all admit that the meeting had gone off satisfactorily. Some of them would remember that, in the address he delivered two years ago, he took up the subject of carburetted water gas, and gave some figures which, to his mind, proved conclusively that water gas could not be manufactured so cheaply as coal gas. They had still this fact to bear with; and the poisonous nature of the gas remained, no matter what might be said about the cost. In his opinion, some of the speakers had been rather hard on tar distillers. He himself manufactured sulphate of ammonia. While admitting that they made a profit by it, they must on the other side of the account put the trouble and inconvenience it sometimes gave; and for a small gas-works, he, like Mr. M'Gilchrist, would not recommend anyone to put down sulphate plant. Acetylene was a subject with which he thought they were all conversant. He had noticed an account of a party who had been in the habit of using acetylene gas, in whose hands a tin of carbide or calcium exploded when he was opening it. It appeared that the carbide, even in a sealed tin, had gathered a little moisture, and the man opened the tin with a red-hot iron. No wonder there was an explosion. There was, therefore, he thought, a good deal of danger in the use of acetylene gas. He understood that the fire insurance companies placed a very high premium on buildings where acetylene light was used. They required, too that the generator should be placed at least 30 yards from the building that was to be lighted. This also militated against it. High-grade gas was a subject which was very often before them. Time was a mighty changer; and there was no doubt that as gas became more extensively used for other purposes than lighting, it might become more advantageous for them to manufacture a gas which would be better adapted to these purposes, though it might be less suited for lighting than high-grade gas. The new incandescent gas-burners were wonderful; but he should like to know if they were likely to get mantles which would be less fragile than those now in use. He understood that with the new burners the Welsbach Company had been able to raise the illuminating power to more than 30 candles per cubic foot; and so this was a factor which was likely to compete with the electric light. This was a matter in which all were interested. They had all experienced difficulties in purification. No matter whether their works were large or small, they had found themselves caught at times when they least expected it. Some of them might have noticed that the purifiers showed a foul test—just a very little—and that they were somewhat hot. This, of course, pointed a lesson. The lime must have been put into the purifiers too hot, or perhaps it might not have been sufficiently slaked, and the gas, in passing through it, deposited a little moisture, which raised the temperature of the lime. He had also seen purifiers giving a foul test when the lime was quite cold and the gas at a lower temperature than when it entered. He had got over this difficulty by putting in the lime thoroughly slaked, with a little heat in the gas to impart a higher temperature to the lime. He once had a man "gassed," at some distance from the town, and they laid him down with his face to the earth. It was wonderful to see the power the earth had in drawing the gas out of the body. He was glad, personally, from the position he occupied, that the meeting had proved so successful; and he hoped this would be their experience in the future.

The CHAIRMAN thanked the meeting for their assistance in threshing out the points raised. He would have liked to hear more said regarding purification and the heating of purifiers, as mentioned by Mr. Yuill. Acetylene had hardly been spoken of; but it was almost a stranger among them yet.

Mr. YUILL proposed Mr. W. Ewing, of Hamilton, as Chairman of the meeting next year.

Mr. M'GILCHRIST seconded the proposition.

Mr. EWING agreed to act, and returned thanks.

Mr. Yuill was re-elected Convener of next year's meeting.

A vote of thanks to the Chairman closed the proceedings.

The company, to the number of over seventy, afterwards dined together in the hotel—Mr. Pooley presiding. The toast of "Kindred Associations" was proposed by Mr. A. Wilson, and responded to by Mr. T. Wilson, on behalf of the North British Association, and by Mr. W. B. M'Lusky, on behalf of the Waverley Association.

WAVERLEY ASSOCIATION.

HALF-YEARLY MEETING, APRIL 14.

The Seventy-fourth Half-Yearly Meeting of the Association was held in Milton Street Hall, Edinburgh. This was the first occasion on which the Association had met in the Metropolis of Scotland; and it being somewhat of an experiment, there was some anxiety as to the result. This was, however, altogether satisfactory to those who advocated the change from the practice of holding the spring meetings in localities where members are situated, to Edinburgh, which is better for access than are some of the towns in the area embraced by the Association. There was a large attendance of members, from all parts of the district. In addition to these, there were also present, in an official capacity, Mr. T. Wilson, of Coatbridge, the President of the North British Association of Gas Managers; Mr. A. Bell, sen., of Dalkeith, the Past-President; Mr. A. Yuill, of Alloa, a member of the Committee; and Mr. R. S. Carlow, of Arbroath, Secretary and Treasurer—all of whom attended with the view of enlisting the support of the Waverley Association to the scheme of the North British Association for the standardizing of meter-unions. Mr. W. R. Herring, the Engineer to the Edinburgh and Leith Gas Commission, was present during the latter part of the meeting; and there were also in attendance Mr. James Milne, Mr. Henry O'Connor, Mr. A. MacPherson, Mr. D. Macfie, Mr. Lumsden, and Mr. W. D. Helps, of Leeds, as representatives of Messrs. James Milne and Son, Limited, of Edinburgh, London, Glasgow, and Leeds, whose guests the Association were at the termination of the meeting.

Mr. H. RUTHERFORD (Aberlady), the President, took the chair. In his introductory remarks, he said he had no practical address prepared; believing, as he did, that this being the first time the Association had held their meeting in Edinburgh, it would be more a day for sight-seeing than for speech-making. Having nothing to bring before them which was new, he also thought it would be presumptuous in one who held a very small position in the gas profession to come there to address gentlemen who, he knew, had had far more experience than himself in matters pertaining to gas and its manufacture. But as an old member of the Association, he might mention that the old members never had any pretensions whatever in the way of reading papers; and, if his memory carried him right, the Chairman was only appointed on the morning of the meeting. They had, however, the same objects in view then as now—meeting together for the purpose of exchanging ideas on all matters connected with the gas industry. As an old member, he was very pleased that they were progressing; and he had no doubt they would continue to do so, as he might say that the Association consisted nearly altogether of new members since he joined it—with perhaps the exception of Mr. Taylor, of Jedburgh, their much-respected and esteemed late Secretary and Treasurer. Some of the younger managers, who had been fortunate in obtaining the places of their older colleagues, had seen their way to connect themselves with the Association. But there were still a number in the district who might join them; and if they saw their way to do so, he was sure that the Waverley Association would go on prospering in their hands—knowing, as he did, the superior education and the practical training in chemistry which they now received. He trusted they would excuse him saying more, as they were to have an informal discussion, and were also to consider the proposal of the North British Association as to the standardizing of meter-unions. He hoped their proceedings would be beneficial and enjoyable to all.

Mr. T. Wilson (Coatbridge) said he was sure the members were all very much indebted to their worthy President for his address; and though it did not contain much matter for discussion, he thought he was entitled to their thanks. The President spoke of being a manager "in a small way." Well, he had been a manager in a small way himself; and he considered that, if a man was to understand the manufacture and distribution of gas thoroughly, he must go through the "small way" first. As to meter-unions, he might say that the Committee of the North British Association had communicated with all the kindred Associations in Great Britain on the subject, and it had been decided that Mr. Carlow should read a paper upon it at the meeting of The Gas Institute at Belfast in June. The subject would then be thrashed out; and he thought it would be in the interests of gas companies and corporations if it could be secured that a uniform size of couplings should be adopted.

Mr. W. B. M'Lusky (Selkirk), the Secretary, said that, since Mr. Wilson had mentioned meter-unions, he might read at that stage the circular he had received from Mr. Carlow. In it he said: "I shall esteem it a favour if you will lay this circular and relative reports before your Association at as early a date as convenient; and, in the event of the proposal being favourably received, I would suggest that a Sub-Committee from your Association should meet with other representatives, in London or at some other convenient centre, when the whole subject could be fully discussed."

Mr. W. **Blair** (Haddington) said in his opinion it would be of great advantage to all gas companies and corporations, and also to meter makers, if they had standard sizes. He thought the initiative should have come from the makers years ago. When a meter was going wrong, if he had not a union to suit it he hesitated to take it out; but if he had an interchangeable one, he would have it out at once. He might, in this way, save nearly 2s., as compared with having to get another meter. He hoped that at the meeting of The Gas Institute something definite would be done.

Mr. J. **Richmond** (Dunbar) endorsed what Mr. Blair had said, but expressed the opinion that they should have a standard height of meter as well as a standard size of union, because he had seen a meter fixed where another maker's meter would not fit. Nevertheless, it would be a vast improvement to have a standard for unions.

Mr. A. **Bell**, sen. (Dalkeith), pointed out, with reference to Mr. Blair's remarks, that the meter makers started in business, and made their own patterns, long before these things were thought of; and their businesses had grown as gas-works had grown. He had had a good deal to do with this matter; and, instead of requiring to force them, the meter makers had been in hearty agreement with the Committee. The makers had actually paid for the standard unions. The only thing they said was: "Give us some certainty of finality; do not have us altering our standards again." It was not only the couplings they had to alter, but they had to keep immense stocks; and if there was no finality in the matter, a new set of unions coming out perhaps in a year or two, would be troublesome, if not ruinous, to them. The whole of the hitch which had occurred had come from their having applied to the Board of Trade. He held that the Board of Trade, whatever moral power they might have, had no legal authority to do anything in the matter. This subject had nothing whatever to do with the measuring vessel. It simply had to do with the connections; and it was for the meter makers and users of the meters to say what sizes they wanted. He was not clear that they should trouble with the Board of Trade, unless they could get them to act freely, giving their moral sanction. The meter makers were ready last New Year to issue the unions, if the Committee had only given them their word that there would be finality; but this they could not do in the meantime.

Mr. **Blair** said he did not mean to make any reflection on the meter makers, but they knew that in the adoption of the Whitworth standards for iron there had been no compulsion; and he did not see why the same standards should not be made applicable to meter-unions.

Mr. D. **Vass** (Portobello) thought the remarks made by Mr. Richmond were very much to the point. Without a standard height of meters, they would be just left where they were as regarded the changing of meters. He thought they should not do one part and leave the other undone. If the subject was to be taken up by Associations all over Britain, might they not go a little farther and communicate with Foreign Associations? They also dealt largely with the home meter trade.

Mr. T. **Wilson** said that, for their information, he might mention that the North British Association had not only adopted a standard pitch of thread, but a standard coupling. He did not know that they should have anything to do with Foreign Associations, because they might come and interfere with them. If it was in the interest of gas companies in England, Scotland, and Ireland to adopt a standard union, it would surely be to the interest of foreign companies and corporations to do the same. In Coatbridge, he changed from 500 to 600 meters every year. These standards would save him money; and if they were to be a saving to a little town like Coatbridge, they must effect a much larger economy in big places like Edinburgh and Glasgow.

Mr. R. S. **Carlow** (Arbroath) said he could assure them that the Committee of the North British Association devoted a great deal of time and attention, not only to the height, but to the form and the shape of the couplings. They would be uniform all through.

Mr. J. **Renfrew** (Langbank) asked if the couplings would be interchangeable.

Mr. A. **Bell** replied that Nos. 3 and 5 were interchangeable; but No. 2 was not with either. The reason for this was that a No. 3 would suffice for the lighting of a house, but if a small stove were put in, it would not be so then, unless with a larger meter; and they had made the coupling to fit a larger pipe than would be required for the lighting. To make meters uniform in height was a separate question from that of the unions. Meter makers held patent rights, patterns, and everything else, after their own ideas; and to ask them all to make their meters according to one size, would be tantamount to asking them to throw up their businesses.

Mr. A. Yuill (Alloa), referring to the "Transactions" of the North British Association of two years ago, said he found that the size of the 2-light meter coupling was ½ inch; and of the 3 and 5 light meters, ¾ inch.* So that, in changing from a 2 to a 3 or 5 light meter, an alteration would require to be made; but in changing from a 3 to a 5 light meter, it was patent to everyone it was simply a case of connecting on. He thought that the Association ought to take the initiative in the matter, and place it in the hands of their executive to watch over the proceedings—more especially the proceedings at The Gas Institute meeting in Belfast this year. In this way they would lend a hand in having the unions standardized. He had no doubt but that, if it were taken up, these couplings would be used largely all over the kingdom; but as to trying to enlist the foreign trade, he did not think they ought to insist upon that at all. Abroad they dealt with the metric system; and he did not think they should encourage anything which would help the introduction of articles "made in Germany." If the meter makers found it was going to be advantageous to them to increase their trade abroad, they would find ways and means of doing it.

Mr. Blair moved that the matter be remitted to the executive of the Association, to do what they could towards the attainment of the end in view.

Mr. J. Richmond seconded the motion.

Mr. A. Scott (Markinch) asked permission, not being a member of the Association, to say how pleased he was to hear the subject of meter-unions spoken of as it had been. The manner in which it had been treated was a guarantee that it was only a question of time when the unions would be adopted. Was it necessary that they should have the sanction of the Board of Trade? Seeing that both this Association and the North British Association were unanimously in favour of standardizing the unions, he thought there was really nothing to hinder their universal adoption.

Mr. A. Bell thought it was well that they should thoroughly understand the position of the Board of Trade. The Board, as the members all knew, had power over the measuring vessel. Meters were now under the Weights and Measures Acts. Consequently, the Board of Trade had power over the body of the meter. But this was a question only of the connections, over which, he believed, they had no authority. The Board of Trade could not say what sized pipe they were to attach to the meter. But some members of the North British Association thought they should apply to the Board of Trade in this matter; and this view was adopted at a meeting. The Committee, while they thought it unnecessary, were agreeable, and applied; and it was only then that the hitch occurred. It was after the North British Association had adopted the couplings, and had purchased the standards and paid for them, that the Board of Trade sent down from London a set of couplings, which had been lying on their shelf for ten years, and said they proposed to adopt them. The Secretary wrote to the official of the Board of Trade who had to do with the matter, and asked if he would refer to the law which gave them power to enforce their standards. The reply they received was that there was no law, but that they were thinking of getting one. These unions were still lying in Edinburgh. They were very good, but they were not like theirs. They had a special thread—not what could be called a common thread. While they would be uniform, there would be just as many couplings as now. There was a universal thread—the Whitworth—for iron; and this was the thread the North British Association had adopted. With it as the thread of the meter-unions, if anything went wrong they might be able to repair it themselves, as they would have their iron thread at hand. This was one great advantage they would have if the North British unions were adopted.

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* See "Reports of Gas Associations for 1896," p. 162.

Mr. VASS thought this question led them to the subject of the sizes of pipes inside buildings, which he considered to be one that Gas Associations might take up. House proprietors ought not to be permitted to put in pipes which were too small.

Mr. RICHMOND remarked that this was a matter for each Local Authority to deal with. They did so in Dumbarton, where the Corporation told those who were erecting houses that unless they put in certain sizes of pipes they would not be supplied with gas.

Mr. RENFREW said that in Paisley the Corporation had printed regulations to the same effect.

Mr. BLAIR reminded the members that some years ago the North British Association issued a circular with regard to standard sizes of pipes. This was all very good, so far as regarded new houses; but in towns where gas had been in use for (say) 60 years it was very different. In many instances they found nothing but ¼-inch pipes. He had had occasion to send through a ⅜-inch pipe gas for ten or a dozen burners. The members could guess as to the complaints they had in such a state of things. He thought that if they were to distribute the circular of the North British Association to plumbers and builders, it would do a great deal of good.

Mr. CARLOW remarked that he did not think plumbers and builders were so much to blame for inadequate piping as architects, who cared no more for the gas manager than for the man in the moon. They seemed to think they had all the wit and wisdom in the world.

Mr. W. SMITH (Melrose) thought Mr. Carlow was about right. He had an instance where a new house was being built with twelve or thirteen apartments, and thirty lights, and yet the architect recommended a ½-inch service-pipe.

Mr. T. WILSON thought that Mr. Carlow had struck the nail on the head. If they educated the architects, the matter would be all right. In those towns where they could dictate to the proprietors of houses, they were in a very happy position. In Coatbridge they had no control over the matter. The Company had nothing to do with the sizes of the pipes put in, but had simply to furnish a supply of gas. The smallest pipe they laid was 4½ inches; so they showed the architects that they did not wish to put down small pipes.

Mr. W. B. M'LUSKY said that in Selkirk they submitted a circular to the Dean of Guild Court, and got it approved of. The advantage of this was that, having the approval of the Court, that body called the attention of architects to the fact that the Gas Company would not supply gas unless the pipes were of a proper size. He thought that the matter of the standard dimensions of pipes was just like that of the meter-unions. It might be said that it was no use beginning to move in this matter, because they could not interfere with old houses; but they must begin some time, and the sooner the better.

The PRESIDENT concurred with Mr. Carlow, and pointed out that at the last meeting of the Association he said he did not see why plumbers should require to be registered and architects should not. He was aware that it was very difficult to induce architects to do as they would like, with regard either to gas or to water pipes. Until they enlightened architects, they would never get gas supplies as they should be. He had to thank them for the discussion which had taken place. He thought Mr. Carlow might rest assured that the Association would do what they could to assist him in endeavouring to get the standard unions adopted.

The remit to the executive was then agreed to.

Mr. J. M'Laren, of Duns, was chosen as President for the ensuing year; Mr. M'Lusky being re-elected Secretary and Treasurer.

Mr. BLAIR presented the President with the Association's medal, as a *souvenir* of his year of office.

The PRESIDENT returned thanks, and expressed the special pleasure he would have in looking back on the fact that he reigned over the Association in the year of the Diamond Jubilee of Queen Victoria.

This concluded the meeting.

The members of the Association and their friends then visited the works of Messrs. J. Milne and Son, Limited, adjoining. In the meter-shop there was an interesting row of meters on a shelf, containing thirteen specimens of meters of ancient design; one of them being a horizontal-dial wet meter about eighty years old. There was just completed a photometer for a gas-works in Kent, containing some late improvements—such as Mr. O'Connor's patent adjustable meter, as described by him at the North British Association meeting in Edinburgh two years ago, in which barometric and temperature variations may be eliminated; and also a pressure indicator recently patented by him which works by means of water in the periphery of a wheel. In another part of the works, there was seen under construction a station meter of 80,000 cubic feet capacity per day, for the Perth Gas-Works. Composite dry meters, in which the lower part is of cast iron and the upper part, containing the index, of tin, were also seen in course of construction. The engineering shops were visited; and in them some large orders under execution were explained to the visitors. Thereafter brassfounding and finishing were shown—everything being seen in process, from the making of the alloy to the burnishing of the finished article.

Messrs. Milne and Son afterwards entertained the visitors to light refreshments. Brakes were in readiness, and a drive of nine miles, to Queensferry, was enjoyed. Dinner was served at the Hawes Inn—Mr. M'Laren being in the chair. Here the company were joined by Mr. J. M'Gilchrist, of Dumbarton. A short toast-list was gone through rapidly; and then those who cared to avail themselves of the opportunity mounted the steep ground behind the hotel, and were permitted to walk the entire length of the Forth Bridge. Mr. Hunter, the Superintendent of the Bridge, accompanied, and explained the structure.

EASTERN COUNTIES ASSOCIATION

HALF-YEARLY MEETING, APRIL 20.

This Meeting was held at Peterborough; and there was a fairly large gathering—several gentlemen having been specially invited to be present in view of a proposed discussion on the standardizing of meter-unions. During the morning some of the members visited the gas-works, for the purpose of inspecting a temporary installation of the Somzée-Greyson gas-light, for which arrangements had been made by Mr. Albert Ranson, the Secretary *pro tem.* of the Syndicate who have taken in hand the introduction of the light in Suffolk and North Essex. The conditions, however, under which the installation had been made were not favourable to a perfect display of the capabilities of the light. Subsequently light luncheon was provided at the Grand Hotel; and at two o'clock, the members assembled at the Guildhall for the transaction of business.

On the PRESIDENT (Mr. J. T. Jolliffe, of Ipswich) taking the chair,

The HON. SECRETARY (Mr. J. H. Troughton, of Newmarket), read the minutes of the meeting held at Ipswich in September, 1897, and they were confirmed.

REPORT AND ACCOUNTS.

The Committee's report and the accounts for 1897 were then submitted. The former chiefly consisted of a review of the work of a very successful year under the presidency of Mr. Jolliffe; and it also showed that, both in regard to membership and financially, the Association was gaining strength. At the commencement of the year, the number of members was 64, and 6 new ones were elected; making the total membership 70. The Committee regretted that the Association had lost one member by death—viz., Mr. W. J. Wells, of Stamford, who had served on the Committee, and was one of the original members of the Association. Five members had resigned; and six had severed their connection with the Association under Rule 17. These losses reduced the membership to 58, to which 11 new names were added at this meeting. The accounts for the year showed that a balance was brought forward of £23 12s. 3d.; subscriptions received during the year amounted to £36 15s.—making a total of £60 7s. 3d. The expenditure totalled to £21 12s. 10d.; leaving a balance in hand of £38 14s. 5d., with a few subscriptions outstanding.

The PRESIDENT thought the report and accounts might well be taken as read.

The suggestion was adopted.

NEW MEMBERS.

On the proposition of the HON. SECRETARY, seconded by Mr. J. G. HAWKINS (Spalding), the following gentlemen were elected members: Mr. John Young, of Norwich; Mr. F. R. Hunter, of Clacton-on-Sea; Mr. Alex. Mitchell, of Bury St. Edmunds; Mr. G. R. Casterton, of Biggleswade; Mr. T. Burtonshaw, of Felixstowe; Mr. J. A. Young, of Louth; Mr. J. Beck, of Stamford; Mr. G. H. Chapman, of Stamford; Mr. H. G. Edwards, of Gorleston, Great Yarmouth; Mr. R. Dawbarn, of Wisbech; and Mr. W. Beale, of Royston.

STREET LIGHTING BY INCANDESCENT GAS-BURNERS.

The PRESIDENT said, in regard to the next item on the *agenda*, he was sorry to have to make an apology. Mr. Sayer, the Gas Inspector of Ipswich, promised that he would read a paper reviewing the subject of street lighting; but at the last moment he informed the Secretary that he would be unable to do so on this occasion. He (the President) confessed this rather staggered him at first; for they trusted to the paper to occupy most of the time that afternoon. The review would undoubtedly have been most interesting; for Mr. Sayer had taken an active part in the improvement of street lighting. Under the circumstances, he (the President) had put together a few fragmentary remarks on the subject; and these, he hoped, would be the means of raising a discussion. He would, however, ask the members not to be too critical, as he had himself been much pre-occupied.

The HON. SECRETARY, at the request of the President, read the paper, as follows:—

Satisfactory street lighting should at least allow you, when walking in the streets, to readily recognize the features of any passer-by. Anything less is not satisfactory; and in very populous and busy centres, more is required. Mr. Sugg, in a paper which he read before The Gas Institute in 1879, laid down a reasonable and fairly practicable standard for street lighting. Some of you may probably remember the clever cartoon which accompanied the paper, in which a gentleman was portrayed, full clothed and with the regulation top hat, walking along the highway, carrying at the end of a stick a lighted lantern. Mr. Sugg, in his paper, said: "The standard is a man lighting his way with a lantern. The light is fixed to a stick in the manner most approved by our ancestors. It is, in fact, so used in the country at the present time. The height of the lantern from the ground is just 2 feet to the centre of the flame. If the lantern is provided with a parliamentary spermaceti candle, it will, in the position I have stated, light a circle 4 feet in diameter. The amount of light anywhere on the edge of this circle will be sufficient to enable a man with good eyes to read a leading article in 'The Times' newspaper lying on the ground. This light will just enable a man to see his way before him as he walks. In a well-lighted neighbourhood, where the local authorities allow each lamp 5 feet of gas per hour, and there are no shops, it will be found that this is the average kind of light which is found at 7 ft. 6 in. from the lamp-post—the lamp being 10 feet from the ground." He also, in the same paper, gave a diagram showing that, with a 10-candle burner fixed upon a post 8 feet high, this light is given on the ground at nearly 10 feet from the post. With a 20-candle burner, this light is found 15 ft. 9 in. from the post; with a 50-candle burner, 26 feet from the post; with an 80-candle burner, 33 ft. 6 in. from the post; with an 115-candle burner, 39 ft. 6 in. from the post; and with a 200-candle burner, 45 feet from the post.

Here then is a standard worked out to lights of varying intensity, and from which we can at once calculate how near to this standard of excellence is the lighting of the streets of the towns with which we are more particularly identified, and see whether it is possible for us, without materially increasing the cost to the ratepayers, to approach this standard.

To illustrate what may be done, I will state my own experience at Ipswich. In that town, the maximum distance apart of the lamps is 80 yards. In the centre of the town, the distance is not so great; and I am glad to say that, on the advice of Mr. Sayer, this distance is gradually becoming lessened. Prior to 1870, the consumption of gas in each street-lamp was at the rate of 5 cubic feet per hour. In that year (probably from motives of economy —evidently very mistaken motives), the rate of consumption was reduced to 3½ cubic feet per hour; and you will readily understand what a miserable exhibition the street lighting became. Instead of being able to recognize people at any spot between the lamps, it was impossible to recognize your most intimate acquaintance at the base of the lamp-post; and, as a safeguard, the lights were absolutely useless. This system remained in force until 1887, when the consumption of gas in a number of the lamps in the centre of the town was increased to 5 cubic feet per hour; and gradually the number was extended.

After some long and exhaustive trials with incandescent burners in the public lamps, I suggested to my Directors that we might, with advantage, undertake to light the whole of the streets in the borough with these burners; and knowing how desirous our Lighting Inspector was to improve the street lighting of the borough, I intimated to him that we were not indisposed to co-operate with him in any scheme he might formulate for the consideration of his Committee. The outcome of this was the subjoined report, which Mr. Sayer laid before his Committee, and which was accepted.

Report made by Mr. E. C. SAYER, *Gas Inspector for the Borough of Ipswich, to the Electric Lighting Committee on the Cost of Adopting the Incandescent System of Gas Lighting for some of the present Public Street-Lamps.*

The incandescent gas-burner may be said to consist simply of two essential parts: First, a carefully adjusted burner of the bunsen type, in which air is mixed with the gas before it burns, generally in the proportion of 30 of gas to 70 of air, producing a substantially colourless or slightly blue flame. Second, a mantle composed of certain rare earths—zirconium, lanthanum, thorium, and cerium.

The incandescence is due to the heating of a network of oxides of the above rare earths, which emit, at the temperature of the bunsen flame, a bright, steady, and powerful white light.

Relative Illuminating Power of Various Burners compared with the Welsbach Burner and Oil.

Burner.	Pressure in Tenths.	Gas Consumption Cubic Feet per Hour.	Candle Power per "Methven" Standard.
Bray's batswing, No. 4	10	5·00	4·8
Bray's batswing, No. 5 . . .	10	6·00	9·6
Ordinary street governor . . .	10	5·00	14·0
Ordinary argand burner . . .	10	5·00	15·8
Welsbach burner, with glass chimney	10	3·75	68·4
Welsbach burner, with mica chimney	10	3·50	60·0
Welsbach burner, after three months in use	10	3·75	40·0
"Belge" oil-lamp	Consumption 2 oz. per hour.		16·0

The light of the Welsbach burner is intensely white and brilliant; being equal, for only 3½ cubic feet of gas consumed, to a maximum of from 50 to 60 candles, and a certain average of 40 candles.

The photometric measurement of a mantle that had been three months in constant use is interesting, as showing how satisfactorily the illuminating power is maintained, while its illuminating power (expressed in candles) is more than three times as great as the best ordinary gas-burners or the incandescent electric lamp—each of which does not generally exceed 16-candle power, unless a very great expense is no object to the consumer. I am far from saying that the incandescent system of gas lighting has now been brought to the highest pitch of perfection. Still I am bound to regard it as the system of gas lighting which utilizes most efficiently and most economically the full powers of coal gas as an illuminating agent. Some have expressed fears that the burner is a delicate instrument; but I have found, with ordinary care, that these fears need not exist. The average life of a mantle, taking risk of breakage into consideration, is between three and six months. But I have used mantles over a year; and at the end of this time their lighting efficiency was still very good.

The cost of each street-lamp burning 5 feet of gas per hour is now as follows:—

Number of hours that each public lamp is burning = 3670.

3670 × 5 = 18,350 at 2s. 10d. per 1000 feet . =	£2	12	0
Less discount at 5 per cent.	0	2	7¼
Cost of gas	£2	9	4¾
Lighting, extinguishing, and cleaning	0	17	0
Total cost of lamp per annum	£3	6	4¾

If the incandescent system were adopted, the consumption of gas would be somewhat less, and the cost as follows:—

3670 hours × 3·75 feet per hour = 13,765 feet, for burner.
5096 „ × 0·25 „ = 1,247 feet, for bye-pass.

Total gas . . . 15,036 feet.

15,036 cubic feet at 2s. 10d. per 1000 . . . =	£2	2	7
Less 5 per cent. discount . . . . =	0	2	1½
Cost of gas	£2	0	5½
Lighting, extinguishing, and cleaning	1	0	0
	£3	0	5½

Total cost of gas, lighting, cleaning, &c., but exclusive of renewals of mantles and chimneys.

Present total cost per lamp per annum . . .	£3	6	4¾
Cost of incandescent burner, exclusive of renewals of mantles and chimneys	3	0	5¼
Balance	£0	5	11½

Now, assuming that each burner needs six mantles, six mantle rods, and two glass bowls per annum, we have £3 0s. 5½d. + 7s. 6d. + 3s. 3d. = £3 11s. 2½d. per annum as the total cost of each incandescent lamp; being 4s. 9¾d. per annum more than the present cost. There are 820 lamps burning 5 feet per hour. Therefore 820 × 4s. 9¾d. = £197 6s. 3d.

The introduction of incandescent burners will, however, enable the Authority to reduce the consumption of gas in 57 large lamps as follows:—

34 lamps now burning 7 feet, reduced to 5 feet per hour, 34 × 2 × 3,670 = 249,560 cubic feet
23 lamps now burning 10 feet, reduced to 5 feet per hour, 23 × 5 × 3,670 = 422,050 „

672,610 cubic feet at 2s. 10d.	= £95	5	8
Less 5 p.c. disct.	4	15	8
	£90	10	0

Deducting this saving of £90 10s. from the above cost of £197 6s. 3d., and adding £13 14s. 4d. for the above 57 lamps, gives £120 10s. 7d. as the probable net additional cost of adapting incandescent burners to 877 of the public lamps. I have every reason to believe the Company would fall in with the above arrangement; and our borough would lose the stigma of being the worst lighted town in the Eastern Counties.

(Signed) E. C. Sayer.

A contract for three years was entered into between the Corporation and the Gas Company on the terms set forth in this report. The burners were duly installed—the result being very striking, and the satisfaction of the ratepayers immense. Whereas before the assumed standard for public lighting extended only to the edge of a circle having a diameter of 20 feet with the lamp-post as its centre, under the improved conditions the standard was 60 feet. The Corporation obtained five times the amount of light for an increase of about 1½ per cent. in the expenditure.

For this installation it was decided to use the Incandescent Gas Company's "C" burner, fitted with bulb and metal reflector, bye-pass lever cock and chains, and anti-vibration springs specially made by them for street lighting. This form of burner was chosen because of its greater strength, and its better capability to withstand the rough usage of street lighting. No alterations were made to the lanterns beyond reducing the size of the apertures at the top, and completely closing the openings at the bottom, excepting the small holes made in the glass for the chains to work through. Before fixing the burners, the upright pipes were shortened to allow of a T-piece with plug being inserted just below the burner. The object of the T-piece was to provide means for clearing the service. Above the T an ordinary lamp-cock was fixed, and next to this the burner itself, fitted with a Peebles governor regulated to pass 3·75 cubic feet of gas per hour. The total cost of the installation was something under 15s. per lamp. Our estimate as to the cost of maintenance was six mantles, two glass bulbs, and six props per lamp per annum; and it is satisfactory to know that, after three years' experience, this estimate has not been exceeded.

Care was taken when fixing the burners to keep both the supply-pipe and the burner itself clear of the lantern, so as to prevent as far as possible, damage to the mantles from shock or vibration. The lamplighters report each morning any damaged mantles or defective lights; and men are told off at once to attend to the same. These men become very skilful in the manipulation of the mantles; and it is rarely that they meet with a mishap. It is found in practice that the difference in the gross and the net price of the mantle is sufficient to pay the cost of attention. Although the lanterns themselves require less cleaning than under the old system of lighting, it is very desirable to have both lantern and globe cleaned at least once a week, as dirt seems to interfere more with the light emitted from a Welsbach burner than from an ordinary flat-flame burner. All the burners are thoroughly cleaned and the service-pipe blown out in the autumn of each year.

In concluding these brief and necessarily fragmentary remarks, it will be seen that the incandescent burner offers an easy and economical means of enormously improving our street lighting even in its present form; and if the new burner which the Incandescent Gas Company purpose putting on the market in June next should give anything like the efficiency promised, we shall have at our command the means of giving to the public, at little or no extra cost, a light which will at once fulfil the standard condition fixed by our friend Mr. Sugg. Personally I have no doubt that the promised burner will give, at all events, some of the results promised; for my assistant, Mr. Prentice, has had constructed at our works a bunsen burner so perfect that, when consuming 5 cubic feet per hour, it gives a light with an ordinary mantle equal to 130 candles, or 26 candles per cubic foot of gas burnt. If we, with comparatively little or no experience in the construction of burners, can make a burner yielding such high efficiency, what may we not expect from the Incandescent Gas Company with all their skill and experience? Their new burner is to yield a light equal to 30 candles for each foot of gas burnt; so that a burner consuming 5 cubic feet of gas will give a light equal to 150 candles. Lights of this power placed 50 yards apart would brilliantly illuminate any street of ordinary width, and could be carried out where gas is about the same price as in Ipswich at a cost of about 9d. per mile per hour.

Discussion.

The PRESIDENT, in inviting discussion, said the reason he asked Mr. Sayer to read a paper on the subject of street lighting was because Mr. Best, at a previous meeting, alluding to some of his (Mr. Jolliffe's) presidential remarks, expressed a desire, if it had been proper, to discuss some of the matters relating to incandescent street lighting. The opportunity to discuss them had now arrived; and he trusted Mr. Best would start the discussion by giving them his views.

Mr. W. J. BEST (St. Ives) said he had done a little with incandescent street lighting; but he could not report much progress. In his town, the lamp-pillars were somewhat "flimsy," or not very substantial; and the roads were made of cobbles. When a traction-engine passed over these roads, the vibration was very considerable, and it resulted in great destruction of the mantles. In addition to this, the lanterns were of octagon shape; and too much wind and draught got into them, which helped to wear out the mantles. The Corporation and the inhabitants would like to see improved lighting; but neither they nor the Gas Company felt disposed to buy new lamps and posts to meet the requirements of incandescent gas lighting. During a visit to Leicester, he noticed outside the gas offices, some substantial pillars and lamps for incandescent gas lighting, which appeared to be perfectly wind-proof, and which were ignited by means of electricity. This was one of the finest and most up-to-date arrangements he had seen for outside lighting. In his opinion, where they had not good substantial pillars and lamps with nearly air-tight lanterns, incandescent burners could not be used with success.

Mr. W. D. CHILD (Romford) thought the members would all agree that, in these latter days, lighting authorities and committees were more alive to the question of street lighting than they formerly were. But it appeared to him, from his experience, that they were hardly going on the right lines. They looked at the lighting question too much from the rate-collecting point of view; and, instead of taking upon themselves to light efficiently a given area, they were induced to light large districts by such considerations as the positions of the residences of the heavy ratepayers. In this way, they were led to spread out their ordinary street-lamps (in his own experience he had had to contend with this) to as much as 100 and 120 yards apart. The only usefulness of a lamp under such conditions was to show there was a light there, and to prevent people running against the post—it was really of no value either for walking or driving. However, the lighting of towns had been much improved of late by the adoption of incandescent burners; but, so far as he had gone, he could not nearly approach the figures given by the President. The paper spoke of six mantles per lamp per annum; but, in his experience, the number ran from twelve to fourteen. Since last Christmas, in 160 lamps, he had used 546 mantles; and even now, though he renewed them so frequently, he was hardly giving satisfaction to the Lighting Committee of the town. Directly they saw a ragged edge at the bottom of a mantle, the question was asked whether it should not be renewed. He thought there was something special about the busy portion of his town which conduced to the destruction of mantles. The subsoil was clay, and the roads were made of macadam. The vibration was very great—so much so, that he had seen a mantle jump off the crutch or support while the man was engaged in fixing it. Such extreme vibration as this had to be met in special places either by suspending the burners, or by other means. He had in some cases adopted a simple form of stand made of light wire, with a piece of rubber tube connecting the burner and the supply-pipe, so as to reduce the vibration of the burner as much as possible. He thought that everyone who adopted incandescent lighting should at once face the question as to whether it was not advisable to have new lanterns adapted both for the purpose of ventilation and the method of fixing. He had nothing to complain of as to his lamp-posts—they were of substantial construction, and well fitted. But they had the old cradle arrangement, in which the lantern hung loosely in the cradle; and, in a high wind, there was sufficient vibration in the lantern itself to cause it to jar against the stand-pipe, and break the mantles. Every lantern used for incandescent lighting should be fixed where the lantern had a frame coming down, with bolts on to a frog, so that there was no chance of the lantern jarring against the lamp-post. This was one of the greatest causes of breakage in his case. He thought, taking the first cost of an installation into consideration—not only the burner, but also the lantern itself, with the proper attachments —it would ultimately pay any gas company to make a complete installation rather than go on with old lanterns improperly ventilated and fitted. In such old lanterns he found a great cause of complaint was that the heat generated was sufficient to break the top glass, and cause a streaming down of a white condensation, which required considerable attention in cleaning the lanterns in order to get a good lighting effect.

Mr. R. G. Shadbolt (Grantham) expressed his regret that Mr. Sayer had been prevented from contributing to their proceedings on this occasion. From the experience he had had of that gentleman, he had looked forward to something out of the ordinary in connection with street lighting that day. With regard to the President's paper, he did not look upon it as a "fragment." It might be so from the President's point of view; but, in his (Mr. Shadbolt's) opinion, if it were a fragment, it was a very good one. It was a fragment snatched from the oblivion of the past so far as Mr. Sayer's report was concerned; and if it had not been brought forward in the manner it had been that day, it would perhaps have been overlooked, or lost to them altogether. Taking the first part of the paper, it struck him how much better it would be if gas managers could have the lighting of the streets of their respective towns in their own hands from the branch to the burner, including the lamp and the pillar. He knew of several places, and one in particular, where the lamp columns and heads were provided by the Local Authority, and the gas was purchased from the Gas Company at the lowest possible rate. The consumption per lamp was 3 cubic feet per hour by a Sugg regulator burner; and the lamps were placed not less than 100 yards apart. In these enlightened days, how town councils could expect their streets to be properly lighted under such conditions, he could not conceive. The great obstacle in the way of improvement was that the lamps were not in the gas manager's hands. At Grantham, they were in a different position. They had the lighting in their own hands; and he ventured to assert that where this was the case the lighting and everybody concerned distinctly benefited from the arrangement. There was one thing in the paper that struck him as being rather peculiar. In fixing up the incandescent burners, the President said that below the tap he arranged for a T to be placed, for the purpose of clearing the service. He should like to know what was meant by "clearing the service." In his comparatively short experience of these matters, the service-pipes had not required cleaning, but the incandescent burners themselves had needed a great amount. In the first table in Mr. Sayer's report, he stated that a No. 4 Bray's batswing burner, at a pressure of 10-10ths, and a consumption of 5 cubic feet, only gave 4·8-candle power, which he (Mr. Shadbolt) presumed meant per foot per hour.*

The PRESIDENT said he could not positively say; but he should think not.

Mr. SHADBOLT observed farther down the table that a Welsbach burner, consuming 3·75 cubic feet of gas, gave an illuminating power of 68·4 candles.

The PRESIDENT said he believed the figures were total values in all cases.

Mr. SHADBOLT (proceeding) said, if this was so, then the Bray batswing burner gave less than 1 candle per cubic foot per hour. He judged that this was the meaning of it; and, if it was so, it must have been a very bad burner indeed. The same might be said with regard to the second burner referred to. In tests of his own, he found with an ordinary burner—one of Hawkins and Barton's regulator burners—consuming 5 cubic feet of 17½-candle gas per hour, he could obtain a light of 14 candles. With respect to the cost of incandescent lighting worked out on the basis given in the paper, he did not quite agree; but he did agree that six mantles per lamp per lighting season—in his case 3000 hours—was borne out in practice. He might also say that the renewals of rods and globes were in the same proportion as was given in the latter part of the paper. When they wished to introduce incandescent gas lighting into the streets of Grantham, he put it to the Corporation this way. The Company, he might first explain, owned the lamp columns, and all pertaining to them; and they did the lighting by contract. They had a sliding-scale according to the price of coal. If the price of coal increased by 1s. per ton, they obtained 1s. more per lamp per 2000 hours—that was for lamps burning 5 cubic feet per hour. He worked the matter out, and then put it to the Corporation in this way: "If you are public-spirited enough to increase the cost of public lighting by 16 per cent., we are prepared to increase the light over that obtained by the 5 cubic feet burners by

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* After the meeting, Mr. Sayer sent to the *Journal of Gas Lighting* a communication in which he stated that the figures given for the No. 4 Bray burner were incorrect. They referred to a No. 3 burner; and those for a No. 4 should have been, at 1-inch pressure, 5·4 cubic feet consumption, and 6·2 candle power. The burners tested had been in use at the Ipswich Town Hall.

300 per cent.;" and the Corporation accepted this. The members had heard that at Ipswich and elsewhere six mantles would represent the renewals per lamp per annum; and this was about correct. At Grantham they had come as low as five mantles; and, so far as concerned breakages, they could have come lower still. But he must confess that they had had to renew the mantles not because they had been fractured, or because of the vibration or other outside cause, but simply because the light had become dim. It was not for them as ordinary gas managers to debate with chemists the causes of this depreciation in incandescence—as to whether it was due to catalytic action, or whether the mantle simply tired out. Whatever the cause might be, it would interest members to know that he had two mantles in use to-day which gave as good a light as when they were put on two years ago. But, generally speaking, if they attempted to do with less than six mantles per lighting season of 3000 hours, they were compelled to renew the mantles owing to the dimness of the light. In this respect, the new Welsbach burner and the results obtained by Mr. Prentice were remarkable. He (Mr. Shadbolt) concluded that the highest duty with the incandescent gas-light was obtained when the mixture of gas and air in the bunsen burner came nearly to the explosive point. He had arrived at this opinion especially from experiments with the "Sunlight" burner. Still the results obtained by Mr. Prentice far and away exceeded anything he (Mr. Shadbolt) had been led to expect. The Welsbach Company claimed that, with their new burner, not only could they obtain 30 candles per cubic foot of gas consumed, but if they had a variation up to 9 or 10 cubic feet per hour, they could obtain an equal proportion of light. He confessed that he could not see how this was done. Mr. Best had evidently fallen upon evil times and evil circumstances; and he commiserated most sincerely with him in his position. He (Mr. Shadbolt) had not been called upon to deal with "flimsy" lamp columns, because the Company had to provide them. He could not conceive himself that the stability of the lamp column could have as much to do with the destruction of mantles as the position of the service-pipe, and its contact with the kerb or channel stones. He had taken out service-pipes that had passed under the kerb or channel stones, and which had touched at one particular point; and it required careful investigation to find out where the contact really occurred. He had had a Denayrouze lamp which had given good results where the bowl of an ordinary incandescent burner was shaken off by the vibration. They tried

the Denayrouze burner because it had no bowl to topple off; and they found the mantle withstood the vibration very well. But a most remarkable thing had occurred. The vibration was of such a nature that it gradually worked out the bye-pass screw until it fell to the bottom of the lamp; and yet the mantle itself was not injured. He could not tell the cause of this vibration, unless it was this: The road was asphalted some time ago, and the surface was rather rounded. He was of opinion that the channel stone which pressed against the side of the lamp column touched the kerb, and this in turn touched the service—causing it to be in intimate contact with the coating of the road. This resulted in a certain amount of compression, which caused the shaking. Although they had a variety of lamp columns, their experience so far, with the exception of this case (which they had not so far disposed of), was that it had been the service-pipe and not the lamp column which had been the ruin of the mantles. As to anti-vibrators, he had heard it said that, as a rule, they were more mantle destroyers than mantle savers. This was also his experience. They had tried all sorts of devices, but had discarded them altogether.

Mr. Best asked to be allowed to explain that the streets in his town were cobbled; and, living in an agricultural district, the traction engine was a frequent visitor. After one had passed through, they found many of the mantles were destroyed. In macadamized streets, they would not have so much vibration as in cobbled streets.

Mr. F. Prentice (Ipswich) said the subject of incandescent lighting was one that had interested him greatly, and one in which he had made a vast number of experiments in many directions to try to find a good burner; and hence this discussion appealed to him especially. Mr. Best seemed to have had great difficulty with his efforts in this way; and he attributed it largely to the posts and to vibration. He (Mr. Prentice) was very much of the opinion of Mr. Shadbolt, that the posts had nothing whatever to do with it, but that it was the service-pipes that required protection in order to prevent vibration. In Ipswich, they had a variety of means of doing away with this destruction of mantles. But while one method answered very well in one lamp, it did not necessarily follow that it would answer in another, because the destruction of the mantle might be due to a different cause altogether. Although they now used less than six mantles per lamp per annum, he was pretty well certain this number could be reduced by at least half when every lamp had been specially attended to. In cases where a large number of mantles had been broken, when the reason was found out, the lamps would go just as well as the others. They had some instances in which the mantles had been in use for twelve months without breaking. In the lamps at Ipswich they used frogs; it was certainly unfair to put mantles in lamps that swung about. They had a great number of traction engines in the town. They made them there by the hundred; and they were sent out at all times for the purpose of testing them. They were driven up and down the streets, and shook the place very considerably. But this had not been found to be a serious cause of breakage of mantles, if the service-pipes were laid in a proper manner. Regarding the depreciation of the mantles, they had not experienced it at Ipswich to anything like the extent that Mr. Shadbolt appeared to have done. There were one or two things that he had noticed which caused the mantles to become dim. One was the partial passing of unpurified gas. If there was a slight taint of sulphuretted hydrogen in the gas, in his opinion it reduced very materially the lighting value of the mantle. Another cause of dimness of the light in the summer time was this: If one looked inside a burner, he would find some thousands of tiny flies, filling up the bottom of the burner almost entirely. It was remarkable how they got in. He was of opinion that, if Mr. Shadbolt took off his mantles, and thoroughly blew out the burners, he would get something like 40 candles out of them, or almost the same light as when he started. Mr. Shadbolt was under a strange misapprehension when he said that the new Welsbach burner would give 30 candles per foot of gas for any quantity consumed from ½ foot up to 10 feet per hour. The misunderstanding was consequent upon a statement made by the Chairman of the Welsbach Company; and perhaps Mr. Sheldrake, who was present, would be able to give them some information on the subject. The Welsbach Company he (Mr. Prentice) understood made a variety of burners which would give 30 candles per foot for the quantity of gas the burner was made to consume. This did not seem so unreasonable as the other statement.

Mr. SHADBOLT: I fail to see how it can be reduced *pro ratâ* to any particular consumption for one burner.

Mr. PRENTICE said he had not had an opportunity of experimenting with, nor did he know anything about, the new Welsbach burner; but he had no doubt that the result he had mentioned could be obtained. He had come very near it himself; and it was not a difficult thing. If they studied the flame itself, and simply endeavoured to produce a flame of such a size that the mantle could be suspended in the hottest part of it, they could get 26 candles per foot of gas consumed. He had obtained 26·9 candles; and, after a little more experimenting, he thought he would get a result as high as was claimed for the new Welsbach burner. The Somzée-Greyson burner gave 30 candles per cubic foot of gas consumed. He had tested it most carefully in a photometer; but at first he was not particularly favourably impressed with it, because of the necessity of having to get the high pressure of 7½ inches for it.

Mr. Shadbolt wished to add, with regard to the cleaning of the burners, that every time they renewed a mantle the burners were taken to pieces, and cleaned thoroughly.

Mr. A. Drage (East Dereham) said that, some two or three years since, thirty incandescent lamps were fitted up in his town. With regard to the mantle renewals, during the first year the lamps were lighted, 8 dozen mantles were purchased. They did not light for the whole of the year; and, if they did, the renewals would not average more than three per annum. During the year they only had two bowls broken, and 72 rods, which gave a lower average than was allowed in Mr. Sayer's report. Of course, East Dereham was only a small town; but to his own knowledge there were thirteen traction engines in the neighbourhood, and these were running backwards and forwards through the streets all day long. He had never had any mantles broken by vibration. He thought the fault of mantles being fractured in this way was that the service-pipes were laid too fleet in the ground. He placed his service-pipes as deep as possible; and he had no trouble whatever from vibration. He considered that some of the new lamps were not sufficiently heavy for the lights; his old lamps were all heavy ones. The only drawback was that he found he had too much ventilation; and he had to block up some of the top ventilation in order to maintain the lights. By using the bulb form of burner in the old heavy lanterns (which were all made of copper), the mantles were not broken. He did not renew a mantle directly he found a ragged edge; but he did so as soon as the light began to burn dim. To obtain the greatest efficiency, much depended upon the mixing of the gas and air. With some of the burners, he had found that, by placing his fingers over one or two of the air-holes, the light was much increased. In these cases, he had taken the burners to pieces; and by rymering the holes out where the gas passed through, he had obtained the same amount of light as the other burners gave.

With regard to the burner-tap, he had discarded the chain and ring system, as he found the chain often caught on the glass, and had introduced copper wire, so that there was no friction. He was now doing away with the tap belonging to the burner, and was working the bye-pass direct from the service-cock on the pipe. By doing this, he had saved several mantles.

Mr. J. H. **Sheldrake** (of the Welsbach Company), having been invited by the President to speak, said he had listened with considerable interest to the discussion. He thought the members would all agree with him that the great points in incandescent street lighting were to have the service-pipes properly insulated away from the lamp columns, and to have properly constructed lanterns. He had frequently found where there was a great breakage of mantles, that the lanterns were either open at the top or bottom to such an extent that the lights were subjected to winds and inclement weather; and under such conditions, the mantles, of course, did not stand a fair chance. In the course of his experience, he had come across numerous instances round about London where there was great waste of mantles through vibration produced by the traffic. On investigating the cause of this, he had in most cases found that the service-pipes were so wedged into the columns that every vibration on the road was conveyed direct to the mantles; but by releasing the wedges, the breakage of mantles had been arrested. As to the new burner which was shortly to be introduced by the Welsbach Company, the previous night he had tested one from which he obtained 114 candles light for only 4·2 cubic feet of gas. It was a burner without a chimney. The burner had not yet left the laboratory; but there would be an exhibition in London at the beginning of May.* He firmly believed the new burner would be a great success, especially for street lighting. It would also be adapted for domestic use; but for street lighting he was convinced it had before it a very great future. Some eight or nine years ago, he had the honour of speaking to the Prince of Wales at Sandringham; and His Royal Highness then expressed the opinion that the lighting of the streets of London was a disgrace to the country, compared with the lighting on the Continent. He believed that a burner consuming 4 cubic feet per hour, and giving an illuminating power of 100 candles, would be generally adopted. That was what was wanted.

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* The exhibition was held at Niagara Hall. For an account of it and a description of the burner, see *Journal of Gas Lighting*, Vol. LXXI., pp. 1009, 1057, 1062.

Mr. R. J. SHARMAN (Wisbech) said that last year his Company had occasion to enter into a fresh contract with the Corporation for street lighting; and the latter expressed a wish that the Company should put up a number of incandescent lights. He could not give any figures yet, as he had not made up the accounts. It was, however, probable that they would lose on the incandescent lighting the first year; but it would fall upon him (Mr. Sharman) to see that they did not do so in future. At the expiration of twelve months, it was likely that the Corporation would ask them to increase the number of lights; as it was stipulated in the contract that the Company should put up a certain number each year. In his small town, they had nearly 350 street-lamps, with a population of about 12,000; so that it would be seen they were not backward in the matter of street lighting. Previous to the introduction of incandescent burners in the town, he fixed one of the lights close to the river side and near a small wooden bridge, where there was no end of vibration. The results were most satisfactory. They did not use more than three mantles a year—that was lighting 2600 hours; the lamps being turned out two months in the summer time. With regard to general incandescent lighting, however, they had not come down to six mantles per lamp per annum, or anything like it. But when they got things into a better state, and could give more time to the lamps, he hoped to come down to six; and he was inclined to think the number would go even lower than that. In conclusion, he expressed a preference for the suspension form of lamp.

Mr. CHILD wished to supplement his previous remarks as to the use of anti-vibrators. He had a number of incandescent lamps fixed in the Market Place, which was paved with granite cubes. He exercised the utmost care in fitting these burners and lanterns; but, notwithstanding, they had breakages every three or four days. He found a simple remedy for this. Instead of fixing the burner direct on to the top of the stand-pipe, he made a support of four wire legs, riveted to a centre plate of sufficient strength to carry the burner, which he connected to the stand-pipe by a piece of good black rubber tube. Whereas formerly the life of the mantles was only two or three days, by this simple arrangement they now lasted four or five months. He did not think the number of hours the lamps were burning had the slightest effect upon the life of the mantles—they were just as likely to be injured when not in use as when alight; nor did he think that the quality of the gas had anything to do with the length of their life.

The PRESIDENT, in closing the discussion, said he thought it should be the policy of every gas company to further in every possible manner the lighting of the public streets, and even to go out of their way to do this. It was only by hearty co-operation with the public and lighting authorities that gas companies could hope to hold their own against the more modern competitor. Mr. Best had been very unfortunate in the results of his trials with incandescent lamps; but he should strongly advise him not to give up. Whether his streets were cobbled or not, if he tried, he (the President) was sure he would succeed. He did not believe in the word "failure" at all. Each burner and lamp-post, as Mr. Prentice indicated, wanted separate treatment. That they could be brought into line, he felt perfectly confident. Nearly all the discussion had turned upon the life of the mantle. He told them in the few remarks he had jotted down that his first estimate for renewals had not been exceeded. He could, if he chose, tell them even a prettier tale than that; but it did not suit his purpose to do so. Though the general result had been so satisfactory, they had had lamps in which they had gone to as high as 19 and 20 mantles per annum for renewals. But they found out the cause, and remedied it; and so brought these "troublesome fellows" into line with their comrades. He thought with Mr. Shadbolt that it was better that the lamps and columns should belong to the Gas Company, as they certainly had then a greater control over them, and could attend to them better than if they were in the hands of the lighting authority. Personally, he was not troubled in this respect, as Mr. Sayer combined with the Company to make the lighting as successful as possible. As to the tests of burners given in Mr. Sayer's report, the Bray burners experimented with must have been unfortunate ones, because it was well known that, with 15 or 16 candle gas, they could get a lighting efficiency of 2·3, 2·4, and even 2·5 candles per cubic foot of gas consumed. Beyond this, he agreed with the tests. The sliding-scale Mr. Shadbolt had brought before them was interesting; and it was one they might well copy. If Mr. Shadbolt could give 300 per cent. increase of light for 16 per cent. increase in the gas account for street lighting, the public were bound to gain by it. As to the duration of the life of the mantles, he did not think it wise to allow them to continue in use too long. There was a serious diminution in the lighting efficiency of the mantles after a long life; and if the lighting was to be satisfactory—and that was their aim—he thought it was wise to renew them a little more often. He did not think he should try to make the average life more than three months, or four mantles a year. Cleaning the burners was an important matter. Every autumn they took the burners down at Ipswich, and cleaned them thoroughly before starting the winter. They had at other times to take burners down to clean them; and when this was done, it would be found that the mantles gave almost their former light. In his opinion, Mr. Drage was entirely wrong when he attempted to interfere with the air passages of the bunsen burners supplied by the Welsbach Company. To contract or enlarge the air-holes was a mistake; and, in his judgment, the cause of the diminution of the light must be due to some purely local circumstance. *A propos* of this public lighting question was the Somzée-Greyson light. It was his good fortune to be able to inspect this in London some time back. He was so much struck with it—not probably with the economical results, but with the actual results—that he agreed to undertake some experiments. He found that the efficiency with the ordinary Welsbach mantle was very high—being over 30 candles per cubic foot of gas consumed. But there was one fatal drawback to it, and that was the need of a motor to give increased pressure. The Syndicate sent it out with a water-motor, in order to increase the pressure to 7½ inches; and the burner was so proportioned in its gas area that at this velocity, it drew in sufficient air to bring the mixture as nearly as possible to the explosive point which Mr. Shadbolt mentioned. There was no doubt that to this was due the high efficiency of the burner. He could only regard it as a light that was applicable to certain cases where motive power was handy already—such as for the lighting of workshops, and so on. The Somzée-Greyson people claimed that they had strengthened the mantle, and that they had attained this great end by treating the mantle by some secret solution. After being so treated, the mantle could be handled, which was not the case with the ordinary Welsbach mantle. He was very pleased indeed with the discussion, which had been most interesting.

THE STANDARDIZING OF METER-UNIONS.

The next subject discussed was that of the standardizing of meter-unions. Messrs. W. Parkinson and Co. had sent for the inspection of the members a copy of the set of gauges which was approved by the Board of Trade a few years ago, and there was also a sample of meter-unions from the Gas-Meter Company.

The PRESIDENT, in opening the discussion, stated that a few years ago the North British Association initiated a discussion on the question of the standardizing of meter-unions; and they asked that the matter might be brought before the members of this Association. The subject was so important, that no words of his were needed to introduce it.

The HON. SECRETARY announced that he had received a number of letters on the question, among which was one from Messrs. Guest and Chrimes, who stated that, if the standardizing of meter-unions was generally agreed to by the meter makers, they would be glad to comply.

Mr. H. WIMHURST (Sleaford) thought it was desirable that a standard set of meter-unions should be adopted; and he suggested to the meter makers that they should adopt the standard Whitworth gas-thread for all sizes, so that gas managers could, with their ordinary stocks and dies and tubes effect any little repairs necessary. His own opinion was this (leaving 2-light meters out of the question) that the meter-unions should be made in pairs of the same standard sizes—that was to say, 3 light and 5 light meters, 10 and 20 light, 30 and 50 light, and 80 and 100 light. They were often called upon to replace a 3-light meter by a 5-light one, a 10-light by a 20-light, and so on; and the unions should be interchangeable. The model gauges before them were certainly very nice; but to his mind they did not fulfil what was required, as they were not gas-thread sizes. As far as possible also, the meters from different makers should be the same in height, which would obviate the necessity of altering the height of the service-pipes, in the event of a change being made from one maker to another.

Mr. SHADBOLT inquired what the North British Association suggested.

The HON. SECRETARY replied that they suggested that each Association should nominate a small deputation to attend a conference in London for the purpose of discussing the matter.

Mr. SHADBOLT said it seemed to him it would be futile for them to discuss or suggest at this meeting what they thought would be best; and all that remained for them to do was to select their representatives. He thought it was a desirable object; and with the President's permission, he would move that a deputation be appointed to take part in the conference.

Mr. BEST considered that, if meter-unions were made uniform for all meters up to 10-light, it would be a great benefit to gas managers generally.

Mr. CHILD agreed with Mr. Shadbolt that it would be of little use discussing the details of the matter, and that the best step for them to take would be to appoint a deputation.

The PRESIDENT mentioned that there were several gentlemen present representing the meter makers; and he invited them to briefly address the meeting.

Mr. J. L. CLOUDSLEY (Messrs. W. & B. Cowan) said that he thought the suggestion that had been made by Mr. Shadbolt and Mr. Child was very sensible, and to the point. It would be very difficult to discuss details there; and it would serve no good purpose. The meter makers had for many years been trying to arrive at some uniform standard; and, generally speaking, he thought they were more alive now in regard to this matter than ever they were. The Board of Trade in 1887 issued a report, which appeared in the official records, recommending the dies that were now before the meeting; but the matter was never seriously taken up. However, he believed the Weights and Measures Department were very anxious to co-operate with the gas companies and the trade generally to arrive at a particular standard. He felt sure there would be no difficulty from their side; and it only needed, as had been said, co-operation on the part of gas companies and the trade to arrive at a solution of the difficulty.

Mr. D. MACFIE (Messrs. James Milne and Son) said he felt it somewhat of an intrusion to take part in the deliberations of the Association; but since he had been asked to offer a few remarks on the subject before them, he might explain that his only title to do so was that he had been familiar with the steps already taken by the North British Association in connection with the standardizing of meter-unions. This was no new question; for there had been several attempts, more or less futile, in this direction. There had been some approach to similarity in the screw threads sent out by various makers; but, of course, anything that fell short of interchangeableness in screwed unions of meters of similar capacity did not meet the requirements of the case. Theoretically, there could be no two opinions as to the desirability of having an interchangeable standard series of screw threads; and he did not suppose that any meter maker or gas manager would take the opposite view. If, however, there was to be any approach to the desired uniformity, the proposal must emanate from the purchasers, rather than from the manufacturers, of meters; and accordingly he thought that the subject was one for consideration by District Associations in the first instance. When the result of the discussions was tabulated, some effective step might be taken to give effect to the concensus of opinion. Meter makers could hardly take the initiative; for it was only natural that each maker should think his own range of screw threads to be correct ones; and it was hardly likely that any maker would give up his cherished belief by the acceptance of another maker's series as the standard screw thread to be adopted. All the same, it was possible even now for one maker to supply meters with unions to another maker's standard, if orders were so specified; and there was at least one large gas company who insisted on having unions made to their own gauges. The inference was that, if meter unions were to be standardized, this should be gone about without any reference to the screws now in use, and that a new range of screw threads should be instituted. It should, however, be borne in mind that the ultimate adoption of such a standard would not prove of any immediate advantage, but would be in the nature of legislation for posterity, to which there could be no possible objection, provided that the reform commended itself to the profession generally. The present agitation for standardizing of meter-union was initiated by Mr. Myers, of Saltcoats, in a paper read before the North British Association at Melrose in July, 1895; and, so far as that Association were concerned, the views expressed by Mr. Myers were generally approved. But differences of opinion were expressed as to how effect might be given to these views; and in the light of what had since transpired, it might be suggested that, instead of committing themselves to the series of iron-pipe threads specified by Mr. Myers, it would have been quite sufficient had the North British Association limited their recommendation to the adoption of a standard—leaving the details to be worked out after full and free exchange of views throughout the whole country. This was the position of affairs at the present time. It appeared to him that, if the District Associations should resolve that the standardizing of meter-unions was a desirable thing, and if their resolutions should ultimately be confirmed by The Gas Institute and the Institution of Gas Engineers, the matter would be within sight of easy settlement; and the result would be the adoption of a standard which would be acceptable throughout the whole country. At that stage, the assistance of the Standards Department of the Board of Trade might be requisitioned, with the view of giving effect to the united views of the gas industry. It was no doubt within the knowledge of the members that a set of gauges of iron-pipe thread sizes as suggested in Mr. Myers's paper was prepared at the instance of the North British Association, and it was afterwards discovered that a set of gauges had some years before been deposited with the Standards Department. There were therefore two sets of gauges already in existence; so that they were not limited to "Hobson's choice." He had no doubt that the purpose of the North British Association in agitating for the standardizing of meter-unions would be equally served no matter which set was adopted; or even if, after consultation with the parties interested, it should be thought better to throw both sets aside, and prepare a new and independent set of standards—the settlement would be equally satisfactory as a contribution to the standardizing of screw threads, which in all departments of industry was a consummation devoutly to be wished.

Mr. T. **Wilkins** (Gas-Meter Company) stated that his chief, Mr. R. L. Andrews, had deputed him (Mr. Wilkins) to attend the meeting, and say he was in perfect sympathy with the Association in this matter. Some years ago, when Mr. Charles Gandon was President of The Gas Institute, the subject was discussed, but was allowed to fall into abeyance. The Gas-Meter Company at the time furnished Mr. Gandon with a set of meter connections to a standard gauge; and some time afterwards, they supplied Mr. Chaney, of the Standards Department, at his own request, with a similar set. It might be in the recollection of some of the members that a few years since, when Mr. T. W. R. White, of Sherborne, was President of the South-West Association, the subject was again discussed; but nothing emanated from it. If the question was to be brought to a successful issue, it must be taken up with determination, and the whole of the profession agree to it. The Gas-Meter Company would then be only too pleased to fall into line with gas managers.

Mr. W. E. **Toynton** (Messrs. W. Parkinson and Co.) explained that the set of gauges which the firm he represented had sent down was a duplicate of the set deposited with the Board of Trade. As Mr. Cloudesley had explained, whatever the whole of the profession decided upon, the meter makers would be prepared to adopt. It was for gas managers to say what they wanted; and the meter makers would be only too pleased to supply their demands. Of course, there would have to be a perfectly unanimous decision on the subject, as it would lead to endless confusion if the makers had to keep half a dozen different sizes of unions in stock to supply different districts. Regarding the sizes used now, he did not think there was very much difference in the gauges. In the case of the London makers, he found very little variation; their unions seemed to fit each other's fairly well. He should like to hear the experience of some of the members of the profession in the South, as he knew there was a great deal of difference between the North and the South.

Mr. Wilkins mentioned that the set of unions the Gas-Meter Company had sent down was used by one of the largest Gas Companies in London.

Mr. John Glover (Messrs. Thomas Glover and Co.) said he was closely connected with the set of gauges which was made by Messrs. Parkinson and Co., and brought before Mr. Chaney in May, 1887. With Mr. Chaney at that time, after some considerable trouble, he arrived at a standard which he thought would meet the requirements not only of the meter makers, but of the gas world generally. He might say that the whole of the meter makers south, and he should think two-thirds of the meter makers at Oldham, also some of the Scotch meter makers, were agreed upon a certain standard at the present time. There were in existence between 5 and 6 million meters; and if a new standard was introduced, the meter makers would be only too pleased to fall in with it. He could not help thinking, however, that it would be a great waste of money to adopt a totally different gauge of meter-unions from that existing at the present time. If he might be allowed to do so, he would suggest to the Association, or to whatever body was deputed the task of dealing with the matter, that they should rather form themselves into a Committee of Inquiry so as to ascertain how close the various makers agreed with each other. He thought he was not very far wrong when he told them that three-quarters of the meters now in existence were interchangeable, and that there was only a very small section that came from the north that did not interchange with the standard. Now the history of these unions was this: They arose from a standard which was created by Crosley in his original wet gas-meter. That standard, he believed, was in possession of Messrs. Parkinson and Co. at the present day. The standard for dry meters originated with Richards, who afterwards became Croll and Richards, and subsequently Croll and Glover. These standards, Messrs. Thomas Glover and Co. had in their possession. The only difference between the Crosley and the Richards standards was in the 3-light meter; and the variation was that one had 12½ threads to the inch and the other 13. This was a very minute difference. There was certainly a variation in the nose of the lining; and there was a slight variation in the mouth of the cap. If a Committee of Inquiry were formed, they would find that three-quarters of the present meters in existence were interchangeable.

By doing this, a very large outlay would be avoided. If they went to the expense of altering all their unions and union ends of their pipes, it would represent a large amount. There was no necessity for incurring this expense when such a large proportion of the meters in use interchanged with each other; and it would be found that eventually the minority of the meter makers would have to fall into line with the others.

Mr. **Toynton** asked Mr. Glover whether he had not made a mistake as to the 12½ and 13 threads to the inch in the case of the 3-light meters. Should it not be 18 and 20?

Mr. **Glover** replied that he had made a mistake, and Mr. Toynton was right.

Mr. **Toynton** said the original Crosley standard was 18, and Richards's standard 20.

Mr. W. H. **Johnston** (Messrs. R. Laidlaw and Son) said his firm would be glad to fall into line in any arrangement that was made, in order to bring the matter to a head.

The **President** said it would be folly to discard such a large percentage of their meters as Mr. John Glover had alluded to; but it was very desirable that they should, if possible, have a standard. Whether they had a Committee of Inquiry or a Conference to decide the question did not much matter, so long as some such Committee was formed.

On the motion of Mr. **Shadbolt**, the President-elect (Mr. Child) and the Hon. Secretary were appointed to represent the Association at the proposed Conference.

Election of Office-Bearers.

On the proposition of the **President**, seconded by Mr. C. W. **Grimwood** (Sudbury), Mr. Child was unanimously elected President for the ensuing year.

Mr. **Child**, in responding, said his connection with the Association had been of so comparatively short duration that he was proud the members had asked him to accept the presidency. He should do all he could to maintain the Association at the high standard to which it had been brought by former Presidents.

The **Chairman**, in moving that Mr. H. Wimhurst be elected to the vice-presidency, said they had somewhat sinned in having postponed this honour so long. For the amount of work Mr. Wimhurst had done for the Association, he ought to have been elected President when he retired from the secretaryship.

Mr. **Sharman** seconded the motion, which was heartily agreed to.

Mr. WIMHURST briefly thanked the members for the honour so unanimously conferred on him.

Mr. J. G. Hawkins (Spalding) and Mr. J. E. Buckle (Woodbridge) were elected members of the Committee; and Messrs. Ellis and Panchen were re-appointed as Auditors.

The PRESIDENT, in moving the re-election of Mr. Troughton as Hon. Secretary and Treasurer, spoke of the enthusiastic manner in which he entered into his work.

Mr. CHILD seconded the motion, which was cordially agreed to.

Mr. TROUGHTON suitably acknowledged the complimentary remarks made by the President, and the manner in which the members had endorsed the motion.

VOTES OF THANKS.

Mr. CHILD proposed a vote of thanks to Mr. Jolliffe for the able manner in which he had presided over the Association during the past eighteen months. The members would agree with him when he said that the best interests of the Association had been studied during this period; and their President had done much, by his conduct of the meetings and in other ways, to maintain the standard to which the Association had attained.

Mr. SHADBOLT, in seconding, said he should like to refer to the exceptional period during which Mr. Jolliffe had reigned over them. He had piloted them through a time that was unique in the history of the Association; and he had done it well, taking into consideration the various disadvantages under which he had laboured.

The motion was heartily agreed to.

The PRESIDENT, in responding, said he was extremely obliged for the kindly expression the mover and seconder had given to his efforts.

The services of the Committee, Auditors, and Hon. Secretary and Treasurer were duly acknowledged; and a vote of thanks to the Mayor and Corporation for granting the use of the Guildhall for the meeting was also passed. To the last-named vote, Mr. D. H. REDHEAD, a member of the Corporation and a Director of the Gas Company, responded.

In the evening, the members, with numerous friends, dined at the Grand Hotel.

NORTH OF ENGLAND ASSOCIATION

HALF-YEARLY MEETING, APRIL 30.

This Meeting was held in the Offices of the Newcastle and Gateshead Gas Company; and there was a very good attendance of members. Mr. J. HOLLIDAY, of Scarborough, the President, occupied the chair.

The HON. SECRETARY (Mr. J. H. Penney) read the notice convening the meeting.

REPORT AND ACCOUNTS.

The PRESIDENT moved approval of the statement of accounts for the past twelve months, which had been previously circulated among the members, and which, he said, was very satisfactory—showing a rather larger balance in hand than when the year started.

Mr. C. DRU DRURY (Sunderland) seconded the motion, and it was adopted.

NEW MEMBERS.

The following were admitted to the Association: Members: Mr. James Gibson, Manager of the Gas-Works, Beverley; Mr. John H. Wright, Assistant-Manager of the Gas-Works, Hendon, Sunderland; Mr. J. J. Carr, Secretary of the Tynemouth Gas Company, North Shields. Associate: Mr. H. W. R. Kenningham, Manager of the North Brook Vitriol-Works, Bradford.

The PRESIDENT said he had a rather painful duty to perform. It was to announce the death of one of their members—Mr. J. G. Nichols, of the Darlington Gas-Works. Mr. Nichols was one of those men who did not make themselves very prominent in the ordinary way; but he was one who was always well regarded when known. He (the President) knew him very well indeed, both in business and in private life. The Association had been looking forward to his taking a prominent part in their work at an early period. However, death had intervened; and all they could do was to express their regret.

Mr. D. Terrace (Middlesbrough) then read a paper on

THE ADOPTION OF CARBURETTED WATER GAS.

Although all the circumstances which have led to the introduction of carburetted water gas into the various gas-works could not be enumerated in detail, still, as showing the trend of the question, a few of these may be indicated. The saving of ground-space is one of the principal features of the plant, as only about one-fifth is needed as for the production of the same quantity of coal gas. Thus where coal-gas manufacture is carried on in works which have become congested through repeated extensions in confined areas, and where land could not be readily obtained for extensions, carburetted water gas has come to the rescue; the installations also proving great acquisitions in other ways. Economy in capital expenditure has doubtless weighed with several managers when considering the means for future extensions, as only about one-third the amount necessary for coal gas is required. The saving of holder room may also be noted, as the making power is under such perfect control that in a very few hours additional carburetted water gas can be made to meet the ever-changing requirements of city or town, or, on the other hand, as readily cease to be made—and that without any detriment to the plant. The command of the power of enrichment is an advantage of considerable importance, when it can be accomplished so readily and so economically in comparison with present methods.

Getting an enhanced value in coke sales is not only of great moment, but the smaller yard-space required for storage is of some importance. The prices obtained for the other residuals—tar and ammoniacal liquor—have depreciated very much during the past ten years; being only now about one-half of their former values. It is not too much to expect that when carburetted water gas is in more general use, the greatly lessened products will result in securing as much for them as was received in former times. Instead of paying high prices for the better class of gas coals, selections can be made of the commer kinds, as the fullest quantity of gas can be taken from them, and the standard quality obtained by simply adding a small quantity of oil. In distribution, carburetted water gas has proved its efficiency by curing the naphthalene bugbear, thus affording a happy relief to those afflicted.

These are some of the outstanding advantages accruing from, and induced by, the introduction of carburetted water gas; but it may be observed that they are only possible if the price of oil were to remain such as to make it available for gas making.

In this respect, reference may be made to what the writer had the honour of reading ten years ago to the North British Association of Gas Managers, in his Presidential Address thus—

> The use of oil as a substitute for coal in gas making has again been receiving attention; the very high luminosity of this appearing to be considered one of its principal advantages. This, however, is only one side of the question; and it may be conceded that we, as producers of light, are alive to the merit or otherwise, of employing oil in our manufacture. The system may be suitable where a supply of gas coal at a moderate price is not available; but it will not be generally adopted until the steady price of the raw material makes it more profitable to use than coal.

When this was written, the prevailing idea was to carbonize oil in like manner to coal; and it was not then seriously contemplated that the process of making carburetted water gas as used in America would soon be so general in nearly all the largest towns in this country. As plants of an aggregate daily capacity of 75,000,000 cubic feet have been, or are being erected, it may be safely assumed that not only has the system come to stay, but confidence must be felt that variations in the price of the raw material (oil) will be confined within reasonable limits.

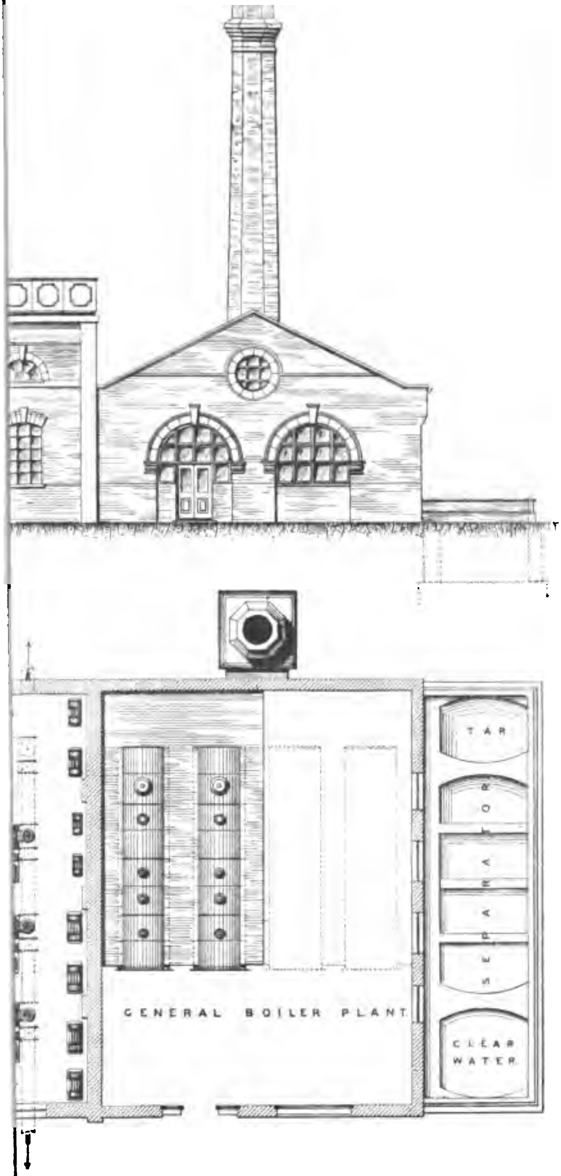
The outline of the working of the apparatus is, no doubt, familiar to many of you; but to make this clear to all, a short description of the plant and the method of working may here be given. The accompanying illustration shows the Middlesbrough installation; the building as illustrated including room for extensions, &c. [See plate.]

The Middlesbrough plant consists of—(*a*) Two sets of gas-generating apparatus, with the necessary washers, scrubbers, condensers, &c., all of which are contained in the generator-house; (*b*) two sets of blowers and engines, exhausters, oil-pumps, lift-pump, and circulating pumps, situated in the machinery-room, which is covered by the circulating water-tank; (*c*) two steam-boilers; (*d*) a tar separator. These constitute the plant proper; but in addition there are a relief holder, four purifiers, a station meter, and oil-storage tanks.

The gas-generating and fixing plant of each set consists of three cylindrical steel shells, termed the generator, the carburetter, and the superheater. Each of these has a fire-brick lining, the space between this and the shell being packed with non-conducting material, which is so effective that the hand can be held on any part of the shells when the plant is at work. The generator is provided with a door on the top for charging with coke; another at the bottom for removal of ashes, &c., from the ash-pit; and also four doors on the side for clinkering, which

URETTED WATER-GAS PLANT WORKS.

3,750,000 Cubic Feet Daily.



doors are all closed during the period of gas making. It is connected both at the top and the bottom by means of pipes to the carburetter. The carburetter and superheater are connected near the bottom, and filled with chequer-brickwork, so that the gas in passing through them comes in contact with a very large heating surface. The generator is filled with red-hot coke, and the chequer-bricks kept at a red heat; the intensity of the latter depending on the class of oil used. The *modus operandi* is then as follows.

The blast-valve on the generator is opened, which admits the air under the fire-grate, and the fire blown up till all the coke is thoroughly incandescent—this being the primary use of the blast. But as the gases formed by the passage of air through the red-hot coke are combustible, advantage is taken of this to keep up the heats in the carburetter and superheater, by having connections from the blast-main led to the top of the carburetter and the bottom of the superheater; and by opening valves on these pipes air is admitted to burn the producer gas, and thus heat up the brickwork. Sufficient air is admitted to bring the brickwork up to the required temperature during the time that it takes to make the coke in the generator thoroughly incandescent; and the waste gases escape through a stack on the top of the superheater. When this stage is reached, the blast-valves are closed, and steam is admitted at the bottom of the generator; a valve on the top of the superheater is closed, to prevent the gas escaping out of the stack; and a measured quantity of oil is sprayed in at the top of the carburetter, where it is immediately gasified. The steam in passing through the red-hot coke is broken up into water gas, which passes through the pipe connecting the two vessels at the top, into the carburetter. It there meets the vaporous oil, which in travelling down through the carburetter and up through the superheater, in contact with the hot chequer-brickwork, becomes thoroughly fixed; and a permanent gas of the desired illuminating power is the result.

When the gas reaches the top of the superheater, it is prevented from escaping up the stack by means of a valve called the stack-valve, which is open during the blow, but closed during the run. It then travels down the off-take pipes (being utilized in so doing to heat the oil which is being sprayed into the carburetter), forces the seal in the washer, passes through the scrubber and condenser, and thence to the relief holder. When this has gone on for a time, the temperature of the fire in the generator becomes lowered, as does also that of the brickwork in the carburetter and superheater; and the steam and oil are then shut off and the stack-valve on the top of the superheater opened, and the blast turned on as before, and the operations repeated. The period during which the blast is used is termed the "blow;" and the gas-making period, the "run."

After a few such runs have been made, in order to keep the bottom of the fire from becoming dead through the constant action of the steam on it, the steam is caused to enter at the top instead of the bottom of the generator, and travel downwards instead of upwards through the fire. By a simple contrivance, the hot-gas valve connecting the generator top and carburetter is closed, a similar one connecting the bottom with the carburetter opened, and the steam made to enter at the top instead of at the bottom by one operation.

The scrubber is similar to an ordinary coal-gas scrubber, and is filled with wood grids; water being sprayed in at the top. The condenser is of the tubular type; and in the Middlesbrough plant, one condenser is common to the two sets. The gas making being intermittent, a relief holder is necessary between the apparatus and the exhausters, to maintain an even flow of gas through the purifiers. One of the old coal-gas holders is used for this purpose. From thence, the gas passes through the exhauster to the purifiers and meter, and is then mixed with the coal gas in our other holders. The purifiers are also a set of old coal-gas ones, four in number, and are worked similarly; the chief impurity to be got rid of by them being carbonic acid. The water used in the scrubbers is supplied from the overhead tank; and after passing through these, it finds its way to the tar separator situated at the end of the buildings. After the tar is separated from it, it is pumped into the overhead tank to be used again. This is the use of the circulating pumps.

The oil is at present brought into the works in tank waggons, and then run into four cylinders situated on supports built in an old gasholder tank. It is pumped thence, by means of the oil-pumps in the machinery-room, through the oil heater in the off-take pipes into the setting.

All the machinery is in duplicate, so that should any part at any time be temporarily out of order, gas making can go on as usual; and so the plant is kept at full work from the beginning to the end of the shift, when gas making is stopped for the purpose of cleaning the fires. Of course, if both sets are at work, one set still keeps making, while the fire of the other is being cleaned. The cleaning, or "clinkering" as it is termed, is done from the four doors on the generator sides; and, as may already have been gathered, it is done once in eight hours—at the end of each shift.

All the valves in connection with the generating plant are worked from the operating floor, and are provided with a patent interlocking gear which reduces the possibility of error to a minimum, by preventing the valves being worked in other than their proper order. The coke used is brought from the adjoining retort-house in hopper buggies, and raised to the operating floor by means of a hydraulic lift; and it is fed, either hot or cold, into the generator by means of the door on the top. The quantity of oil injected every run is measured by means of an oil-meter fixed on a stand in a convenient position for the operator; and a battery pressure-gauge is fixed on the side of the superheater which communicates by means of pipes with the different parts of the apparatus, so that the gas maker can at any time see the pressures at the various points. The whole of the operations are very simple, and the heats can be very easily kept constant; and when once the men engaged become accustomed to the proper heats required for the oil being used, no trouble is found.

The generating plant, as before mentioned, is in two sections, each having a daily capacity of 625,000 cubic feet—making a total of 1,250,000 cubic feet per day; and as these can be got into full working from the cold state well within four hours, to make gas of any required illuminating power, some idea of the utility of the process may be gathered. The plant was erected during the summer of 1897, by Messrs. Humphreys and Glasgow, of London; and it has been at work since last autumn without a single hitch or difficulty. It might also be mentioned that it is capable of extension, at a comparatively small outlay, to something like three times its present capacity, by the generator-house being merely lengthened towards the street line; the boiler-house and the machinery-room being already of ample size to accommodate this, as also to include exhausters required for our coal-gas plant.

You will observe we have been working with temporary oil-storage tanks; the land for the erection of the permanent ones not having been yet secured. This rendered necessary our receiving the supplies in oil-cars, which added materially to the cost of production, owing to the additional charge for carriage, &c., from the West Coast. It is intended, however, to erect oil-storage tanks near the river, so that a tank-steamer can be run alongside, and the oil pumped out of it into them; thus securing from six to twelve months' supply at a time.

When we were working both sets during the winter months, the purifiers which were part of the set for coal gas, used temporarily, were rather overworked; thus also adding to the usual costs during the first season. It might further be stated that, where no profitable market exists for the sale of oil-tar, means are generally taken to use it as fuel for steam-boilers.

Notwithstanding the foregoing drawbacks in our first season, the costs of the carburetted water gas compare favourably with those of coal gas when the quality is taken into account, which is the only criterion of working. Thus—

Cost of 1000 *Cubic Feet of Carburetted Water Gas of* 24-*Candle Power into Holders.*

Wages, making gas	1·0d.	
Coke	1·7	
Oil	9·8	
Purification	1·3	
Wear and tear	0·2	
		1s. 2·00d.

Or 0·58d. per candle per 1000 cubic feet.

Cost of 1000 *Cubic Feet of Coal Gas of* 14-*Candle Power* (*Old Working with Horizontal Retorts*) *into Holders.*

Wages, making gas	4·45d.	
Coals	11·15	
Purification	0·25	
Wear and tear	1·50	
		1s. 5·35d.
Less—		
Tar	1·78d.	
Ammoniacal liquor	0·83	
Coke	4·06	
		0 6·67
		0s. 10·68d.

Or 0·76d. per candle per 1000 cubic feet.

Mixed Gas of 17-*Candle Power.*

70	per cent. of	14	-candle gas	at	0s. 10·68d.
30	,,	24	,,	,,	1 2·00
100	,,	17	,,	,,	0s. 11·67d.

Or 0·68d. per candle per 1000 cubic feet.

Thus the difference between 10·68d. and 11·67d. is 1d. per 1000 cubic feet, for which we get 3-candle power enrichment—*i.e.*, 0·33d. per added candle.

These costs will be greatly lessened when the carburetted water-gas plant is fully completed with permanent oil-storage tanks, and working with inclined retorts, making our fixed working as follows:—

Cost of 1000 *Cubic Feet of Carburetted Water Gas of* 24-*Candle Power into Holders.*

Wages, making gas	1·0d.	
Coke	1·7	
Oil	7·8	
Purification	1·0	
Wear and tear	0·2	
		0s. 11·70d.

Or 0·487d. per candle per 1000 cubic feet

Cost of 1000 *Cubic Feet of Coal Gas of* 14-*Candle Power into Holders (New Working with Inclined Retorts).*

Wages, making gas	2·45d.	
Coals	11·15	
Purification	0·25	
Wear and tear	1·50	
		1s. 3·35d.
Less—		
Tar	1·78d.	
Ammoniacal liquor	0·83	
Coke	5·40	
		0 8·01
		0s. 7·34d.

Or 0·524d. per candle per 1000 cubic feet, making the

Cost of 1000 *Cubic Feet of Mixed Gas of* 17-*Candle Power into Holders.*

70	per cent. of	14-candle	gas	at	7·34d.
30	„	24	„	„	11·70
100	„	17	„	„	8·65d.

Or 0·509d. per candle per 1000 cubic feet.

Or (say) for 1·31d. per 1000 cubic feet we get 3-candle power from enrichment—*i.e.*, 0·44d. per added candle.

The power to meet by oil enrichment the contingencies of varying quality, is found a great advantage in carburetted water-gas making; and when this can be done with coal gas at 7·34d. per 1000 cubic feet, at a cost of less than ½d. per added candle per 1000 cubic feet, its economy, considered merely as a process of enrichment, cannot be doubted.

As the specific gravity of carburetted water gas is greater than common coal gas, we have kept on about 2-10ths additional pressure in the street-mains to meet this, and had no complaints as to want of an adequate supply. Neither has there been any trouble from a certain alleged characteristic of the gas, though we have used from 25 to 30 per cent. of it all through the dark season.

Some of the collateral advantages of the adoption of carburetted water gas have already been mentioned; but, in closing, a few experiences may be given to amplify these. Instead of, as formerly, only realizing at the rate of about 4d. per 1000 cubic feet of gas made for coke sold, about 6d. is now received, owing to the improved market through lessened production by less coal gas being made, and the use of a considerable quantity in making carburetted water gas. Thus, instead of the coke-yard being piled high as in previous seasons, at great cost for trimming, and having to sell what we had at a loss to get quit of it, there is now always a ready sale at very good prices. Consequently, the 2d. gained on coal gas is an absolute credit to carburetted water gas, though it does not appear as such in the foregoing costs, and the mixed gas gets the full benefit of the transaction.

All the gas required was supplied with ease and comfort, though there was only available storage for 1 million cubic feet, while we sent out double that quantity; thus proving that in any works short of holder room, instead of spending (say) £20,000 on a new holder and the land for it, this amount would be of more lasting benefit if applied for manufacturing plant of the type under review—for not only is it extremely useful to make up for lack of storage, but more important even than this is the great facility with which the number of coal-gas retorts are put on and off to meet varying demands. This is managed with a steadiness that is not attainable when coal gas alone is made; as, having carburetted water gas as an auxiliary, there need be no fluctuation in the number of retorts in use, except and only that due to seasonable requirements—all the varying quantities wanted to make up for weather effects being so readily furnished by the immediate increase or decrease of carburetted water gas, and that without the slightest damage to the plant. It need scarcely be mentioned—in fact, it is impossible to say—what lasting destruction is caused to the settings of retorts by the heating-up and letting down, when every storm approaches. Surely if this can be avoided, it is a great boon; and if to this be added the avoidance of anxiety on the part of the manager, and the expense of keeping the retorts and stokers in readiness in case of emergency, the advantage is indeed a great one.

Observation has already been made as to the comparatively small space occupied by the carburetted water-gas plant, and also the great economy effected in capital cost relative to those of coal gas. Taking the area of the Middlesbrough plant as a basis for the carburetted water-gas plant (which not only contains the coal gas, steam, and exhausting plant, but also provision for

200 per cent. extension in these and other departments), and the area of our new inclined retort-house, &c., as the basis for the coal gas, the latter occupies an area about five times that of the former. Whether, therefore, the introduction of carburetted water gas as an auxiliary to the manufacture of coal gas be considered in relation to capital expenditure, ground space required, or economy in working, it will be conceded from the foregoing that, with these and the other advantages mentioned, its adoption has been a decided acquisition.

Discussion.

The PRESIDENT said they were extremely indebted to Mr. Terrace for the able and lucid paper he had given them on the subject of carburetted water gas, which had caused a number of people great fears as to what would happen were it generally adopted. Mr. Terrace had cleared away many of the cobwebs which had been gathering in most of their brains regarding carburetted water gas. So far as he, personally, was concerned, his knowledge of it hitherto was a paper one only; but he hoped he was going to get into close quarters with it very soon. With regard to the saving by it, there seemed to be considerable divergence of opinion. There was a very eminent Engineer in the North who said that in certain districts carburetted water gas was of no good—that what was wanted was extended holder room; that it was much cheaper to put in more retorts, and if a sudden demand for gas arose, and they had good storage behind them, it was better than fitting up carburetted water-gas plant. He supposed this opinion was due to the price of coal in that gentleman's immediate district. There seemed to be a difference of opinion also with regard to the relief holder. Some connected their coal-gas supply and their carburetted water-gas supply directly from the exhausters, and let them mix there. He did not know whether Mr. Terrace had any particular idea as to the desirability of allowing the two gases to mingle in the holder or after the station meter. Some mixed it at one point, and some at the other. He did not know that there was a great deal in it; but in Scarborough they were going to mix them before they passed into the holder.

Mr. TERRACE explained that the gases were mixed by him before they went into the storage holder. The holder shown on the diagram was simply a relief holder. They did not mix the gases until after they had passed the carburetted water-gas station meter.

The PRESIDENT (continuing) said there was this point about the interlocking gear which he might mention—that there was a small plant within a short distance of Scarborough, and he did not know whether it was due to the interlocking gear or to any carelessness in working, but they could hear explosions in the plant all over the town.

Mr. **Terrace**: It must be due to carelessness in working.

Mr. C. **Dru Drury** (Sunderland) agreed with the President in thinking that their thanks were due to Mr. Terrace for the capital paper he had read to them. He, like the President, had only a paper knowledge of water-gas plant; and he should like to ask Mr. Terrace one or two questions about it. He wished to know whether Mr. Terrace had had any analysis of the gases made, so as to show the proportion of carbon monoxide which was sent out with the gas, and whether the calorific value of the mixed gas was lowered to any serious extent. Also whether he had any complaints on this point from the users of gas-engines, and those who employed gas for heating purposes. He would further like to know as to the beneficial effect water gas had on naphthalene. He saw that Mr. Terrace increased the town pressure by 2-10ths, which, he supposed, was just about the amount which was required to meet the increased specific gravity. But he was afraid this would also tend to increase the consumers' bills. He supposed that Mr. Terrace would use the plant to its full power, and that he could not use it to any less extent than its maximum capacity with economy. He desired to be clear on this point. He should also like to know the temperature of the gas as it came from the superheater—before it went into the washer.

Mr. J. **Hall** (Gateshead) said he would like to ask Mr. Terrace what was the effect of the gas when it went into the general holder, if it was stored for a week. How much of the gas was permanent at the week's end? He could quite understand that it was useful for immediate delivery, but that beyond immediate delivery there would be considerable loss. He was quite satisfied that oil gas would have to be the gas of the future, unless they could get their coal elsewhere than where it came from at the present time.

Mr. E. H. **Millard** (Durham) said he also was one of those who simply so far had a paper acquaintance with carburetted water gas; but he was now going a little in for it. What led to their adoption of the process was that their coal had all to be carted into the works, and their coke to be carted away. By this process, however, they would not have the carting of some 2000 tons of coal and 1500 tons of coke yearly; and they would simply have to pay the cartage on 450 tons of oil. So that, as regarded economy, the process should turn out very well with them. He did not think that Mr. Terrace had cleared up the point about the illuminating power. Oil gas was said to be of 24-candle power. Some years ago they had a controversy in the *Journal of Gas Lighting* as to the difference between illuminating power and illuminating effect. He wanted to know if Mr. Terrace got the full illuminating effect of his illuminating power. He himself was inclined to be rather dubious on the point. Their friend Mr. Ford had had a year's working with the process, and he hoped he would give them the benefit of his experience with it.

Mr. W. FORD (Stockton) said he fully expected one of his neighbours to get up and say a few words, so that he might draw Mr. Terrace out a little. As this had not happened, he would make a few remarks regarding water gas at Stockton. He fully considered the matter with Mr. Terrace. They went together on a trip to Belfast to see the plant, and were there very much taken up with it, and recommended it to their Committees. He got a little the start of Mr. Terrace; but his friend had shown more wisdom in putting down a double installation. Their esteemed President seemed to be under a misapprehension as to the relief holder. The manufacture of carburetted water gas was intermittent; and the volume of gas produced was so large that it would require plant, such as meters and purifiers, of nearly ten times the area necessary for the production, unless they provided a holder as a relief. As Mr. Terrace had clearly put it, the blow was four minutes and the run seven minutes. A very large quantity of gas was made in these seven minutes; and if they had to pass all this through their exhausters, it would be altogether impossible to regulate them. He put the water gas into the relief holder, and then mixed it with the foul coal gas; and the two gases passed together through the exhausters, washer, scrubbers, and purifiers, and both went through the same station meter into the storage holder. He was one of those who were severely criticized by their friend from Yorkshire when he said it was simply "duffers" who required to go in for water gas. He did not agree with this. The constituents of water gas were so different from those of coal gas that, as an enricher, it was, in his opinion, the simplest, best, and safest method that could be adopted. It enabled them to have a variety—indeed, a great choice—of coalfields. If they were required, as he was, to produce gas of 16-candle power, to do this from coal they would be tied down to one or two collieries in the district; whereas with the assistance of carburetted water gas they could, as it were, descend the scale of luminosity in their purchase of coal, and with a very small percentage of oil they could in the course of a few minutes increase the illuminating power of the gas up to whatever standard they required. One great benefit derived from the use of water gas was, as had been lightly touched upon already by Mr. Terrace, the removal of naphthalene, of which he had had a very sad and long experience. When he went to Stockton thirty years ago, there was left to him as a legacy, by an eminent engineer in their profession, the question of how to cure it. The simple method of plunging it out was the only one available. He had been troubled with as many as 500 complaints in a day. His only remedy was putting benzol into the pipes. He was proud to say that from a fortnight after they started the carburetted water-gas plant, he had not known of the slightest condensation of naphthalene. It had saved him, perhaps, the keeping of some four or five plumbers to go about in winter attending to naphthalene obstructions. They had, of course, had a very mild winter; but in previous seasons of a similar character he had been troubled with naphthalene. When on a visit to Paris, he saw Pelouze's condenser, and thought it was a perfect cure; but now he questioned very much whether it would be effective with Durham coal. But this he certainly could say—he had not had a single complaint with regard to naphthalene during the whole of last winter. He attributed this entirely to the use of carburetted water gas. Another thing which had possibly more effect in satisfying his conscience than anything else was connected with the Sunday labour question. He had made several futile attempts to allow his men to be off for eight or ten hours on Sundays; but until this process came to his hand, he had never been able to do so successfully. At the point of exit from the water tubular condensers, the average temperature of the carburetted water gas during the past winter of six months was 70° Fahr. The gas at this temperature was going into the holder. He had worked it both higher and lower; but he found that working uniformly at this temperature gave him great satisfaction. He thought the use of carburetted water gas would enable them to benefit this country very much. If they considered the quantity of coal which was exported from England, it was plain that the use of oils from other countries would very likely extend the life of their coalfields, perhaps for hundreds of years.

Mr. T. Bower (West Hartlepool) remarked that, unlike his neighbours, Mr. Ford and Mr. Terrace, he should not be able to give them the benefit of his experience with carburetted water-gas plant, for the simple reason that up till now he had had nothing to do with it. His remarks, therefore, would be confined more particularly to a few general observations with reference to some experience he had two or three years ago—before advising the Company he represented as to the steps to be taken in regard to extensions. At West Hartlepool they were exceedingly cramped for space in more ways than one. They had obtained parliamentary powers for the acquisition of a large plot of land, which enabled them to proceed at once, if they so desired, with the erection of ordinary coal-gas works. They had already a gasholder erected on the plot of land, as a first instalment of a new gas-works; and the question resolved itself purely into one of expenditure of capital as against working expenditure. It was felt by him that the time would soon come when new coal-gas works would be necessary, and that it would only be a temporary tiding over of their difficulties if they were to go in for a carburetted water-gas plant then. The information he obtained at the time led him to the general conclusion that, while the erection of a small installation of carburetted water-gas plant would certainly tide him over his difficulties for a few years, yet there were other difficulties to contend with, which would be very large factors in the question he had to consider. But before giving the meeting his own version, he must make a remark as to what Mr. Terrace put forward as the cost of the production of water gas of 24-candle power. He seemed also to have made very considerable strides in the production of his coal gas. At the time he spoke of, he was not able to get definite information from anyone that he had been able to produce gas at less than 1s. per 1000 cubic feet, into the holder. He thought, speaking generally, it would be found that to-day this was nearer the average figure than Mr. Terrace's 10½d. In fact, he knew some at the present moment to whom gas was costing as much as 14d. or 15d. When he came to the resolution not to go in for carburetted water-gas plant, his decision was based principally on the fact that the cost of production was more than they could afford if they were to sell gas at their then existing rate. Being a Company, they laboured under certain disadvantages which his friends Mr. Ford and Mr. Terrace did not. Very serious objections had been taken to the gas; and they felt that, if there were to be no monetary advantage in adopting carburetted water gas, why should they, as a Company, subject themselves to annoyance? There could be no doubt that gas companies did stand in a different position from corporations in regard to such matters. Corporations had a knack of doing things in their own way, which companies could not attempt. With regard to naphthalene, there could be no doubt that it was a bugbear to all gas managers, and especially to those who were situated in the North-east of England. He had had very considerable trouble with naphthalene; but he was happy to say he was now nearly in the same position as Mr. Ford. They had hardly ever a case of naphthalene now; and he attributed this, not to anything which had been done in the manufacture of gas, but to the exceptionally mild winter they had had. He ventured to say that if they had had such a severe winter as they had some years ago, the result might have been as bad at Stockton and Middlesbrough as it was then; and so he thought it would be rather too much to conclude that carburetted water gas did away with naphthalene troubles. But if it should turn out to be so, it would be a very great recommendation in favour of carburetted water gas. Mr. Terrace touched upon a point which he had not heard mentioned before, with reference to oil tar. He understood Mr. Terrace to say there was no outlet for it. Now, it occurred to him that one of the difficulties at his works was the getting rid of breeze. If there would be another factor coming in which would do away with the sale of breeze, it might be unfavourable to them. In most works they were putting up boilers to enable them to utilize breeze as far as they possibly could, in their own works; and if oil tar took its place, it would be so much the worse for breeze. With respect to the regulation of the quantity of gas, might he ask if Mr. Terrace had any difficulty in doing this. He said that something like 25 or 30 per cent. of carburetted water gas was used; and he (Mr. Bower) took this to mean the average of the total. Might he ask whether, on dark days, when he had been pressed with his coal-gas plant, there was not a tendency to rush in a higher proportion of carburetted water gas, and, if so, what means he had of measuring or gauging the quantity going in? In stating what he had, he wished it to be understood that he was in no way biassed against carburetted water gas—in fact, he was rather more an enthusiast in the matter. But, all things considered, with regard to their own works, he had come to the conclusion that the time had not yet arrived when he might safely introduce it. However, bearing in mind the customary caution his friend Mr. Ford always exercised, he was afraid that he might make him a convert. He believed that

Mr. Ford had obtained excellent results; and any conclusion he might come to would tend to fix their minds permanently on the subject.

Mr. W. Doig Gibb (Newcastle-on-Tyne) said that, in common with others, he had only a paper knowledge of the subject. But about a year ago he had an opportunity of travelling round a number of works in England in which were installed carburetted water-gas plants; and perhaps he might be allowed to read an extract from the report he then submitted to his Directors. Of course, it related to Newcastle, and did not apply to any other place:—

It may be stated that it is useless to consider water-gas plant as a means of producing gas continuously throughout the year in Newcastle, since the local conditions allow coal gas to be produced so cheaply. In 1896, the manufacturing charges for this per 1000 cubic feet were 8·45d., and the charges for water gas of similar value would have been about 11·24d. As against this there is smaller first cost for water-gas plant; but the interest saved on this would not be sufficient to compensate for the higher cost of production when used continuously.

It is held by most engineers that it is absolutely necessary to have about 10 per cent. spare producing power standing idle at the busiest part of the year in case of breakdowns, sudden fogs, want of stock, partial strikes, &c. The question of the cost of producing gas from this spare power is therefore altogether secondary to other considerations, such as the rapidity with which the plant can be got into action, and the quantity of gas which can be produced without depending on a large body of men. Assuming that it be only an emergency plant, I very strongly recommend that it be a water-gas plant, and summarize the reasons which influence me in this decision.

1.—The small ground space occupied.
2.—The saving in first cost of water-gas plant as compared with coal-gas plant would be £15,000 for a production of 1,500,000 cubic feet per 24 hours.
3.—With four hours' notice, cold plant can be working to full capacity.
4.—The plant may be shut down instantly.
5.—The candle power is under the most complete control.
6.—Gas has almost no sulphur impurities. (It has an excess of carbonic acid; but this is not included in legal impurities.)
7.—Its solvent effect on naphthalene.
8.—For enrichment purposes in a large works in Newcastle it would be nearly as cheap in continuous running as using cannel for an enricher.
9.—Independence of crises in the coal supply as long as coke is available.
10.—Practical independence of labour. (In proportion of one to six, and an easier class of men to get.)

This represented his views at the present time. As to the relief holder, he understood that, instead of having to provide purifiers, exhausters, and everything else to deal with the gas produced in seven minutes, they got eleven minutes in which to do it. Mr. Ford's method of working, he thought, suggested several practical advantages. It always seemed to him that if they mixed carburetted water gas with coal gas, and tossed it about in their scrubbers and other plant, it had very much less chance of layering than if the gases were mixed after they had passed through different apparatus. Mr. Bower objected to the burning of oil tar, and spoke of a difficulty in the getting rid of breeze. He suggested whether it would not be possible to make briquettes by a combination of the oil tar and the breeze, and sell them as fuel, as was done in the case of coal dross and pitch. He only suggested this, and did not know whether it was practical.

Mr. Ford asked to be allowed to make one remark with regard to the permanence of carburetted water gas. Without the water gas, his leakage was 5 per cent.; for the year to the 31st of March, using water gas, it was 4 per cent.

The President said he should like to ask Mr. Terrace one or two questions. He was afraid he could not get hold of the idea of the relief holder. He thought he was correct in saying that there were cases in which the carburetted water-gas exhausters and the coal-gas exhausters stood side by side, and where, immediately the water gas passed the latter, there was a connection, and the gases travelled together through the condensers, scrubbers, and purifiers into the holder.

Mr. Terrace said this was so. Mr. Ford worked in that way; and his relief holder was the only means he had of measuring the carburetted water gas.

The President said he understood it now. With regard to the cost of carburetted water gas, it seemed to him to be entirely a question of locality. The cost of coal in Newcastle was so low that apparently it would not be worth while putting down carburetted water-gas plant. Their cost of gas into the holder was 8·45d., as against Mr. Terrace's 10·68d. At Scarborough it cost them 1s. 2·45d. into the holder. They had to pay more for the carriage of the coal from the pits to the works than for the coal itself; and he thought that they would be able to make carburetted water gas at probably 2d. per 1000 cubic feet less than they manufactured coal gas. Oil tar, he believed, was being used for other purposes than boiler firing. He thought there was a firm in the Liverpool district who were using it for enamelling—at least they were making inquiries about it; but he did not know whether or not it was coming into the market as a commercial commodity. He was glad to hear that the quantity of coke used was 40 lbs. per 1000 cubic feet, because he did not think this was generally known. The quantity of water gas which Mr. Terrace put in—25 or 30 per cent.—was, he thought, a limited quantity, compared with some places.

Mr. TERRACE, replying, said there seemed to be a very great divergence of opinion as to the use of the relief holder. Mr. Ford showed clearly that they must have it; that was to say, they were not always producing gas—*i.e.*, "blowing" for four minutes and making a "run" (gas making) for seven minutes. They would understand from the lines of piping on the diagram how he dealt with the two gases. Mr. Ford put his carburetted water gas into the relief holder, and exhausted it from there in connection with the coal gas. He himself measured his carburetted water gas by a separate meter before mixing it with the coal gas; while Mr. Ford measured it mixed with the coal gas. His own system was supposed to be the more complete of the two; it enabled them to know better what they were doing. As they had heard from Mr. Ford, he put down a single plant, which he intended should tide him over present circumstances; whereas at Middlesbrough they had put down a more complete plant. As to the question of the segregation of the two gases, he had found no difficulty in getting them thoroughly mixed. The gases had very nearly a mile to travel together before they reached the holder; and he certainly never found that they separated. As to the question of illuminating power, he found that they obtained the full duty of the gas. They themselves tested it at the works, and the Borough Analyst tested it in the town—taking it from the distribution mains at such a distance from the works that he was bound to get a general average. Therefore he (Mr. Terrace) did not think that any doubt could be cast on the gas, in the way of condensation destroying any of its illuminating effect. Remark had been made about an Engineer in the North having thrown cold water on the gas; but he thought that in the place referred to they had so small an installation of plant that it could not be of much effect.

Mr. BOWER asked if there were (say) half a million cubic feet of carburetted water gas in the relief holder, and a million cubic feet in the coal-gas holder, they had any means of measuring the gas out of the relief holder, or any check upon the quantity sent out to the town.

Mr. TERRACE pointed out that in his case the gases were measured just before they mixed. As to oil tar, they made a very small proportion, and it was sufficient to keep up steam in the boilers for working the generators and driving the pumps and the blowers in connection with the carburetted water-gas plant. Unless they received a good price for it—something like 16s. per ton—it was not worth while selling it. But they were only offered about half this sum; and so they resolved to burn it. Mr. Drury had referred to the calorific value of the gas. In the mixture they used they had only had a difference of about 1¼ per cent.; and they had had no complaint from users of gas-engines, though they had something like 50 or 60 of them in Middlesbrough—some of them being of 200-horse power. They had about 8 per cent. of carbon monoxide in their ordinary coal gas; and using 25 or 30 per cent. of carburetted water gas, containing 30 per cent. of carbon monoxide, they had about 16 or 17 per cent., or nearly double. Mr. Gibb would observe by the paper that by the use of inclined retorts at Middlesbrough the cost of making coal gas was reduced from 10·68d. to 7·34d. per 1000 cubic feet.

Mr. C. DRU DRURY, of Sunderland, read the following paper on

ECONOMICAL METHODS OF RAISING STEAM IN GAS-WORKS.

Engineers and managers of gas-works often have it cast up against them that they, who are always urging the use of gas-engines among manufacturers, do not themselves use them—or, at any rate, employ them only to a very limited extent. If gas companies, it is said, who can have their gas at cost price, do not use it as their motive power, how can the public in general be expected to take it up?

While sympathizing with these sentiments to a large extent, the cause for the reproach is not difficult to find. Steam is an absolute necessity in a gas-works of any size. It is required for steaming out the mains and various portions of the works plant, and also in connection frequently with the revivification *in situ* of oxide of iron in purifiers, and, where sulphate of ammonia is manufactured, for boiling the liquor. In winter, of course, its usefulness is increased, as there is the meter-house to maintain at an even temperature, and also the prevention of freezing in the lutes of purifiers and gasholders, &c. These uses for steam are, however, more or less intermittent; and it is found more economical and practicable, since boilers are required, to make them large enough to provide steam for the daily requirements—such as the driving of exhausters, pumps, &c.—as well. Also the growing practice among gas engineers of manufacturing water gas on their works increases the demand for steam; and thus it comes to pass that even in newly-constructed works, in spite of the adaptability of gas-engines and the great improvements that have been made in them, steam is still employed as the great motive power.

But there is another point of view from which to look at this question of steam using, and one which, in my opinion, is most important—viz., the *cheapness* with which steam can be raised in gas-works. A certain quantity of dirty or small fuel is, like the poor, always with us; and this is either valueless and has to be carted away—perhaps at considerable cost—or commands so small a price as to be practically unremunerative. This can, and should, be used for raising steam. Now, what is the fuel which can be dealt with as suggested?

First of all—and there should not be much of this class in a well-regulated gas-works, though it mounts up when taken over a year's working—there is the coke swept up in the yard, or thrown up from the railway siding, or picked out from the furnace ashes. It is not advisable to mix this with the best coke, as it is generally small, wet, and dirty, and leads to tiresome complaints on the part of customers. In many cases, too, the pan breeze screened from the furnaces is added; and this, of course, reduces the cost of carting away the residual ashes. But unless there is ample accommodation for carrying on the operation, this process is somewhat inconvenient.

Next there is the coke breeze, which rarely fetches more than 1s. 6d. per ton, and except in a few favoured localities is very difficult to dispose of. When burnt, however, by means of a forced draught in a special furnace, of which there are several varieties in the market, it forms an excellent fuel for boiler purposes. No attempt will be made to describe a breeze-burning furnace in detail, as no doubt every member of this Association has either seen them in operation or has one or more of them at work himself. I regret that I am unable from practical experience to give any figures showing the working results of any such furnace. I understand, however, that an evaporative duty of from 5 to 7 lbs. of water per pound of breeze is claimed for them; and there is little doubt that where a plentiful supply of breeze exists—and such, of course, is the case in gas-works—the outlay necessary for a breeze furnace is a profitable one.

A third method of raising steam economically (and the description of this is really the essence of my paper) is that of heating the boiler by means of the waste gases from the retort-settings. And here I would beg leave just to mention that, in bringing this method before the notice of the members of the

Association, I make no claim for originality or for the introduction of anything novel. I merely wish to refresh their memories on the subject, and to draw their attention to the simplicity and economy of the process. I quite anticipate that many present will consider this plan of raising steam obsolete, since, owing to the very general adoption of regenerative (or, more properly, recuperative) furnaces, there is not sufficient heat in the gases leaving the setting for the purpose; and also that it will be said that it is more desirable to utilize as far as possible all the furnace heat in the setting itself, than to produce more than is required and use the balance for some other purpose. To this I, to a great extent, agree, as I am a firm believer in the advantages and merits of generator, if not regenerative, furnaces—especially on the points of ease in regulating the heats and increased life of the retorts. But, for all that, there are many works where it is not expedient or advisable to convert a whole retort-house of direct-fired settings to the more improved principle, especially if the existing furnaces are doing good work.

In the works at Sunderland under my charge, the whole of the settings are on the direct-fired principle; but in spite of this fact, the amount of coke (not coke and breeze) sold per ton of coal carbonized amounts to 10½ cwt. taken over a year's working. This result is largely due to the fact that the greater part of the steam used on the works is raised in boilers heated by the waste furnace gases, by which means the settings affected are, in a sense, converted into the regenerative type. There are at present three boilers heated in this manner; and a fourth is in course of erection. Of the three, two are tubeless, cylindrical, egg-ended boilers, 4 feet in diameter and 36 feet long, while the third is a Lancashire boiler 27 feet long. Experience shows that the latter type is by far the most efficient.

The system of overhead gas-fired boilers was introduced into the Sunderland works by one of my predecessors, Mr. J. T. Jolliffe, a former member and Past-President of this Association; and, with a few modifications, the system is still worked in the same manner.

A glance at the diagram will show that the boiler is hung in such a way as to prevent its weight being carried by the arches of the settings, and thereby distorting them, from cross girders supported by cast-iron columns rising from the ground on each side of the bench; the only extra weight falling on the beds being that of the walls enclosing the boiler-flues. The bench over which the boiler is suspended consists of nine settings of eight through retorts each, of which the arches are 8 feet wide by

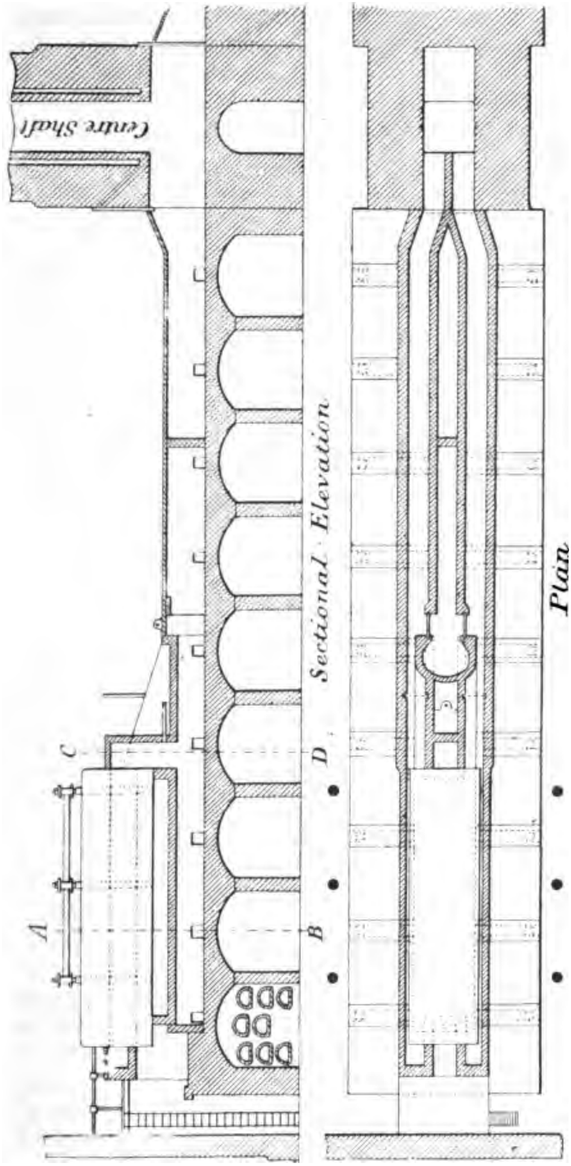
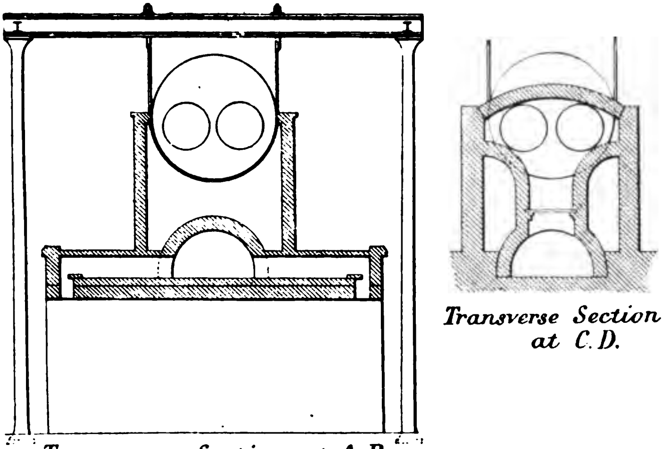


FIG. 4.—OVERHEAD GAS-FIRED BOILER AT THE SUNDERLAND GAS-WORKS.

19 feet long. Of these nine settings, seven are connected to the flues of the boiler. It is found that the waste gases from four settings are sufficient to work the boiler satisfactorily. But, of course, better results can be obtained with the heat from seven beds; and this arrangement allows of the settings being let down in two's and three's for repairs, without laying off the boiler.



Transverse Section at A.B.

Transverse Section at C.D.

FIG. 5.—OVERHEAD GAS-FIRED BOILER AT THE SUNDERLAND GAS-WORKS.

The course of the waste gases is from the main flue through the tubes returning under the bottom of the boiler to the chimney. Dampers are provided for bye-passing the boiler altogether, when it is required to lay it off for cleaning, &c., in which case the gases pass away direct to the chimney.

The dimensions of the boiler are as follows: Length, 27 feet; diameter, 7 feet; the two tubes being 2 ft. 6 in. diameter. There are no cross tubes. The following fittings are provided: One 3-inch dead-weight safety-valve; one compound steam and low-water safety-valve; one 6-inch steam stop-valve; one 2½-inch feed-valve; one 2½-inch blow-out valve; one steam pressure-gauge; two glass water-gauges, placed so that when the water in the boiler is 3 inches above the tubes, it is just in sight in the glass; one ⅜-inch brass tester-cock; one manhole; and one mudhole. There are, of course, no fusible plugs, as they would be quite useless in this case. A small duplex feed-pump is fixed in the retort-house, close to the boiler, for supplying the water; and the gauge glasses are placed in such a position that they can be easily seen by the retort-house foreman, in whose charge the boiler is placed, and who is paid a nominal sum for looking after it. His duties consist in regulating the feed-water supply, and in sludging the boiler once per shift.

The cost of such a boiler erected and set is as follows: Boiler and fittings, £270; columns and girders, £126; erecting and setting, about £130; feed-pump, about £24—or a total of £550. The extra cost of suspending is, of course, much more than compensated for by the fact that no house or chimney are required to be erected.

A number of experiments were made to ascertain how much work could be got out of this boiler when the waste gases from seven settings were being passed under it, with the following result:—

Duration of test	8 hours.
Water evaporated	1890 gallons.
Temperature of feed water	48° Fahr.
Average pressure of steam	32 lbs. per sq. in.

In other words, in eight hours 18,900 lbs. of water were raised from 48° to 276½° Fahr., and evaporated at this temperature. The next step was to find the amount of coke which would have been necessary to do this work; and not considering it sufficiently satisfactory to assume an evaporative duty per pound of coke, experiments on the same lines as the preceding were made with a hand-fired Cornish boiler 20 feet long by 5 ft. 6 in. diameter—diameter of tube, 3 feet. Results were as follows:—

Duration of test	8 hours.
Water evaporated.	1870 gallons.
Temperature of feed water	52·5° Fahr.
Average pressure of steam	30·5 lbs. per sq. in.

Or in eight hours 18,700 lbs. of water were raised from 52½° to 274½° Fahr., and evaporated at this temperature. The amount of coke consumed during the period was carefully weighed, and proved to be 1 ton 21 lbs., from which it was found that 8·27 lbs. of water were raised through 222° Fahr. and evaporated by 1 lb. of coke. The fuel used was best coke, brought straight from the retort-house, but not selected in any way.

Correcting the figures obtained in the experiment with the Lancashire gas-fired boiler to the temperatures in the latter experiment, the weight of water evaporated works out to 18,975 lbs.; and therefore the amount of coke saved in eight hours on the preceding basis is 1 ton 1 qr. 26 lbs., or about 20 tons per week of 6¾ days.

Besides the value of the coke, there is also saved the greater part of an attendant's wages; and assuming the cost of labour that would be required to be equal to 4s. 6d. per day of 24 hours, and taking the value of coke at the low price of 6s. per ton, the actual saving per week by this gas-fired boiler is—

Coke saved, 20 tons, at 6s.		£6 0 0
Labour saved, 7 days, at 4s. 6d. . .	£1 11 6	
Less foreman's allowance . .	0 10 6	
		1 1 0
Total saving per week		£7 1 0

Now the retort-settings are under fire for an average period of 33 weeks in the year; and therefore the total saving per annum by this one boiler is £232 13s.

Here I may say that, though due care was exercised, and the necessary precautions taken to avoid error, the foregoing experiments were conducted upon strictly "working" lines; and the results are such as may be obtained any day of the week. It may be urged that a fair comparison cannot be obtained between a 27-feet Lancashire boiler and a Cornish one 20-feet long; but I feel sure, at any rate, sufficient evidence has been produced to show that the economy effected is not inconsiderable.

To complete the information respecting the gas-fired boiler, temperatures of the waste gases were taken in the main flue before and after passing under the boiler. A number of tests were made; and the results varied according to the condition of the fires in the settings. But all showed that the boiler effected a reduction in the heat of about 700° Fahr.

The temperature before passing under the boiler varied from	1337°	to	1130°	Fahr.
Do. after passing under the boiler . .	645°	„	429°	„
Difference	692°	to	701°	Fahr.

The above temperatures were obtained by means of a Siemens water pyrometer; and to those requiring such an instrument, it can be highly recommended for reliability and simplicity of working. Perhaps it will not be considered out of place if a brief description of it is here given.

The pyrometer consists of a cylindrical copper vessel, containing a second smaller copper vessel with double walls. An air-space separates the two vessels, and a layer of felt the two walls of the inner one, to prevent radiation of temperature. The capacity of the inner vessel is a little over one pint. A thermometer is fixed close to the wall of the inner vessel; its lower part being protected by a perforated brass tube, while the upper projects above the vessel, and is divided into degrees Fahrenheit or Centigrade, as desired. At the side of the thermometer is a small brass scale, which slides up and down, and on which the high temperatures are marked in the same degrees as those in which the thermometer is divided. On a level with the zero division of the scale, a small pointer is fixed, which traverses the scale of the thermometer. Short cylinders, of either copper, iron, or platinum, are supplied with the pyrometer, which are so adjusted that their heat capacity at ordinary temperature is equal to one-fiftieth that of the copper vessel filled with one pint of water.

The method of using the instrument is as follows: Exactly one pint of clean distilled or rain water is poured into the copper vessel, and the pyrometer left for a few minutes to allow the thermometer to attain the temperature of the water. The brass sliding-scale is then set with its pointer opposite the temperature of the water, as shown by the thermometer. Meanwhile, one of the metal cylinders has been exposed to the high temperature which is to be measured; and after allowing it time to acquire that temperature, it is rapidly removed and dropped into the pyrometer vessel, without splashing any of the water out. The temperature of the water will now rise; and after the thermometer has become stationary, the degree is read off, as well as that on the brass scale opposite the top of the mercury. These two values added together give the temperature to which the cylinder has been exposed. With copper and iron cylinders, temperatures of 1800° Fahr. can be measured; but with platinum cylinders, the limit is 2700° Fahr.

In course of time, the copper cylinders lose weight by scaling; and a table is supplied with them with corrections for the diminished weight.

Before concluding, I earnestly trust no one will consider that there is the least intention in this paper of disparaging the gas-engine, or of throwing doubts upon its usefulness in gas-works. On the contrary, I would strongly advocate its use in every gas-works, always provided that a supply of steam is also obtainable; and on those works where only steam-engines are employed, a gas-engine should be introduced at the earliest opportunity, if only to encourage the use of it by others. That gas-engines may be used wherever steam-engines are adopted, needs no demonstrating; and even in the delicate and fluctuating work of driving an exhauster, a gas-engine may be safely and economically made use of, as Mr. Dunn at our last meeting so ably showed, by means of his ingenious contrivance.

I have a fear it may be felt that, apart from its want of novelty and originality, this paper has, if not a backward tendency, a more or less ancient flavour. But I make no apology; for history repeats itself, and the old fashions of yesterday become the new ones of to-morrow.

Discussion.

The PRESIDENT thought they might congratulate themselves upon having had that day two eminently practical papers. He did not think that Mr. Drury should have made any apology with regard to his paper, because it was full of new information—at least it was to him. It contained a number of facts that would be useful to them in their ordinary every-day work.

Mr. E. H. MILLARD (Durham) said he had known two places where the method of raising steam as described in the paper had been in use. They were both works considerably smaller than Mr. Drury's. He himself had had practical experience with one, where there was an egg-ended boiler; and it was not satisfactory. In the summer time there might be three or four beds of retorts at work, and there was not sufficient heat to generate steam. In the winter time, with the extra draught which was required to be put upon the beds, there was absolutely no economy in the raising of steam in this way. He was surprised that in such a place as Sunderland it should be considered that this was equal to a regenerative system in the saving of fuel. Mr. Drury's results were, however, very good; and perhaps the price he got for coke did not commend the other system to him. But he (Mr. Millard) should think that economy in heating could be better obtained by means of regenerative furnaces, than by raising steam in the way described. The boiler was certainly not in a convenient place for working.

Mr. A. C. HOVEY (North Shields) inquired of Mr. Drury whether 32 lbs. was the maximum pressure he was able to maintain by a boiler fired in the way described; and, if so, whether it was the pressure he employed in his works, and whether all his machinery was suitable for such a low pressure. He should also like to ask the minimum number of beds he could fire the boiler with; and he should much like to draw attention to the distance which the boiler would probably be from the engine-house, and the great drop in pressure there was likely to be, owing to the distance the steam would have to travel.

Mr. HERBERT LEES (Hexham) expressed his appreciation of the paper Mr. Drury had brought before the meeting. He could do this the more heartily as he had the opportunity some years ago of placing the other side of the question before the Association—that was the production of motive power by means of gas-engines. He thought an arrangement of the sort referred to in the paper would be useless in a works of (say) from 10 to 14 millions per annum; but he had no doubt that the facts which Mr. Drury had put before them fully justified his adoption of it. Of course, Mr. Drury had told them that he approved of regenerative furnaces; but, taken altogether, the results at Sunderland were so satisfactory that they could afford to consider the matter on its merits. He was very glad indeed that Mr. Drury had brought the subject before them. It would be no use to any of them in small works, because at some seasons they would only have one or two beds of retorts working, and, even with a very small boiler, he presumed that sufficient heat could not be obtained by the method described. A gas-engine also did away with the need for a boiler fireman. Where a man had to be kept to look after the boiler, his (Mr. Lees') experience had brought him to the conclusion that they could work more economically with gas. However, there were both ways of working; and they all wanted to look at these matters from their own standpoint. When they could do this, and could bring to bear on the subjects all the information they could get, they would probably be able each to adopt what would be suitable in his own case.

Mr. W. Ford (Stockton) complimented Mr. Drury on his paper. Some little time ago, he was travelling in Yorkshire in search of electric lighting, and he came across an instance where the whole of the heat required to drive the installation was obtained in the way shown; so that, if they got the heat Mr. Drury did he could only say the matter was worth their attention.

The President said he was at one with Mr. Lees as to its being considered old-fashioned to continue direct-fired furnaces. He had the two kinds in his works, and he was not quite sure that he could not get as good results out of the direct-fired furnaces as he did out of the regenerators. It might be rather a retrograde remark to make in the year 1898; but he did not know that there were not two sides to the question, and he thought that if Mr. Drury were obtaining the good results he was doing by direct-fired furnaces, and utilizing the heat in this way, he was probably getting compensation for the heat which would be used in a regenerative system. As to the disposal of breeze, in Scarborough they sold the whole of it to the electric light people for the generation of steam. They were proposing to put in a destructor, by the aid of which they were to supply electric light at something like nothing per unit; and he supposed he would have to seek another market for their breeze when that time came.

Mr. **Drury**, replying to Mr. Millard, said he did not for a moment contend that this was nearly so good a way of recovering heat as was a regenerative setting, which he thought was far better, from a good many points of view; but when he found two houses of retorts, and knew that it would require a large sum to convert them into regenerative settings and that the erection of this boiler would get them the heat in a simple way, he thought he was justified in adopting this system. They were selling 10½ cwt. of coke per ton; therefore he thought he was justified in continuing this method of raising steam. He was asked about the pressure of steam. The maximum was 32 lbs.; and all his machinery was arranged for working at it. No doubt, if a time came when they should raise the pressure, the boiler could be worked at 50 lbs. The minimum number of beds to be used was four. They were throughs. With less than four beds they would make such wet steam that it would not be workable. Of course, there were disadvantages in having a boiler like this, in that they had sometimes to work settings which were not conveniently situated relative to the boiler. But as he was going to have two Lancashire boilers, he would get over this difficulty pretty well. As to the distance the steam had to travel, they used steam for so many purposes and in so many places that it really did not much matter where they put the boiler. They would, no doubt, raise a good deal more steam than they did, if they arranged the flues for this purpose; but the first consideration was not to damage the beds in any way, or reduce their heat by altering the flues. They made their beds so as to work as economically as they could; and then they used the waste heat of the gases. He was much surprised at one time, to be told that when the boiler was at work there was a better draught on the settings than when it was off. The reason for this he found to be that, when the boiler was off and the dampers were closed, there was behind the dampers an accumulation of dust and dirt which contracted the flue. He thought every gas-works should have a boiler which would burn up the breeze.

THE WORKMEN'S COMPENSATION ACT.

Mr. T. **Bower** (West Hartlepool) said they were all probably aware that on July 1 next, there would come into force the Act called the Workmen's Compensation Act, 1897. The Company he represented had been making inquiries as to what would be the best method of dealing with their liabilities under the Act. There seemed to very considerable doubt as to what were the best steps to be taken; and it was more with the view of stating how far they had gone in the matter, and what they contemplated, that he thought it would be desirable to bring the matter before the present meeting, in order that members of the Association might look more fully into the question and consider what would be best to be done, both individually and on behalf of the profession they represented. There seemed to be great doubt, in the first instance, as to what their liabilities were under the Act. This was shown by the fact that some of the largest insurance companies in the country were quoting premiums as high as 25s. per cent. on the wages paid by gas companies. If such a sum were to be paid, it would be a considerable tax upon gas companies in the future. He was told that the 25s. rate came from an association of insurance companies who had banded themselves together, he presumed for their own protection. Perhaps they fixed the price more as an experiment, in order that they might see what the result would be. He had no doubt but that they knew very well how to take care of themselves, and that they had fixed a margin which they considered would cover any risks which might arise under the Act. But there were other insurance companies who were not in that federation, and who considered that 15s. per cent. was quite sufficient to cover their risks. In the case of his own Company, the whole of the risks they had incurred for several years back had not amounted to more than 2s. per cent. The risks might be greater under the new Act; but, personally, he did not see that they should be very much greater. In all cases of accident, his Company had paid the men half their wages during the time they were off. This was, practically, what was provided under the Act. He very strongly objected to being taxed to the tune of 25s. per cent., when, without any prejudice in the matter, he found that they had not paid more than 2s per cent. in the past. To his mind, it resolved itself more into a question of whether gas companies should play into the hands of the insurance companies, or whether they should take such steps as would mutually protect themselves. It did not seem to him to be unreasonable that gas companies should form an association of their own, which everyone might join, and so they might participate in the advantages which the insurance companies would otherwise obtain if gas companies insured with them. It had recently occurred to him that it would be a very desirable thing that some such steps should be taken, so far as the gas industry was concerned. Of course, the question came up as to who was to take these steps. He mentioned the matter that day, because he knew that other Associations were on the track. For instance, the Federated Marine Engineers at York had that week decided that such an association should be initiated in their industry; and they had gone so far as to fix rates, which were not to be more than about 10s. per cent. Now, if the Marine Engineers could get their risks insured for 10s. per cent., he did not see why gas-works should have to pay 15s. or 25s. He wished every manager himself to look into the matter; and he would suggest that, so far as their Association were concerned, they might safely appoint (say) the President and Secretary to deal with the matter, if perchance it should be mentioned by any of the other Associations, and to deal with gas interests generally so far as the North of England was concerned. He did not think that anything more need be done in the matter at the present time; but it did seem to him to be a pity that, because nobody was looking into the question, they should be charged 15s. or 25s. per cent. for a thing which would not be anything like represented by the benefit to be derived from the payment. He should certainly desire to see something done with regard to general steps being taken. He should have stated that liability was not confined to the Act alone; there was the old liability under the statute, and there was also liability at common law, all of which required to be taken into account. But still, when all was said and done, he thought the rates proposed were much too high. He admitted that the insurance companies had no gauge as to what would be the possible risk under this Workmen's Compensation Act; but, on the other hand, when all allowance was made for this, he thought the rates proposed were too high, and that it was a matter which gas companies might look into, and form a scheme for their own protection.

Mr. J. WHYTE (Seaham Harbour) said he was very glad that Mr. Bower had introduced the subject. He had been asked to do so, with a view to seeing whether gas managers would not agree to the combining of districts in a matter of this kind, and thereby receive the benefits of insurance much more cheaply than they would by insuring with companies. He thought if gas companies would join together, the thing could be done.

Mr. E. H. MILLARD (Durham) remarked that the matter had already been under consideration in his district. His Chairman was also connected with two other companies; and a meeting of the Directors of the three had been fixed, at which they were to consider whether an arrangement to combine could not be made. Mr. Bower was entitled to their thanks for introducing the subject.

Mr. W. HARDIE, jun. (North Shields), said the subject had also exercised his mind a little. He had had several communications upon it with other members; and the general feeling seemed to be that very large works might insure themselves, but that in the case of small works it would be a very unsafe thing to do. He did not agree with Mr. Bower when he said that the risks under the new Act would not be much greater than under the old one. He believed they were very much more severe. Some such scheme as this had been suggested several times in connection with other matters. Mr. Bower had done them a service in bringing the question forward; but if it were to be treated as it had been that morning, and they were to leave the room without anything more being done, the probability was that no good would come of Mr. Bower's proposal. It was possible that a scheme of the kind would take a good deal of time to work out. The Act came into force in July; and if they left the subject where it was, they would not be any better. He certainly thought that any small gas-works which took the risk of the Act on its own head would be running a very great danger.

The PRESIDENT said his understanding of Mr. Bower's proposal was that the President and the Secretary should be appointed to confer with any other Association, or the Parent Associations, on the matter, if occasion arose.

Mr. BOWER thought that Mr. Hardie was quite right, and that it was desirable that they should go a little farther than discuss the subject. He proposed the following resolution: "That the North of England Gas Managers' Association resolve to confer with all other Associations, with a view to some ultimate steps being taken for the formation of some mutual insurance society; and that the President and Secretary be empowered to deal with the matter in future." This might lead to some steps being taken which would not otherwise be done. At the same time, he should like to correct one thing which Mr. Hardie had said. When he spoke of the risks under the new Act not being greater than under the old one, he was alluding to the risks which his Company had experienced—that was to say, they had given compensation where they were not compelled to do so. Risks had been met, and charges incurred by his Company in the past, more than need have been. It had always been the practice of his Company to pay liberally to workmen who might have been injured. This, he thought, was the tenor of the new Act; and the only additional liability which would be imposed upon his Company would be compensation for death, which was not to exceed three years' salary. So that he looked on it that the risks of his Company would not, in the future, be so great as seemed to be anticipated.

Mr. WHYTE seconded the resolution.

Mr. MILLARD said he was rather afraid that to make the movement a national one was to place it beyond the range of practical politics; and he would propose that the movement be confined at first to the members of the North of England Association. He thought they would the more readily get into working order in this way; and the movement might possibly later on go farther.

This amendment was not seconded; and Mr. Bower's resolution was adopted.

The PRESIDENT said that, so far as he was concerned, the insurance companies were proposing to increase his premium by about 1150 per cent. The risks would be a good deal greater; but it seemed that the burden they were proposing to place upon gas companies was much larger than need be.

THE STANDARDIZING OF METER-UNIONS.

Mr. W. HARDIE, jun., said they had received a communication from the North British Association of Gas Managers, asking if the Association would join them in trying to get a uniform standard for meter-unions established. Everyone knew the inconvenience there was with the meter-unions as at present; the meters of one maker not being the same as those of another. The North British Association, during the past year or two, had been going very fully into this matter with the meter makers; and they had prepared a set of standards, which they submitted to the Board of Trade. But they were rather surprised to find that the Board of Trade had already in their possession a complete standard set. Since then the matter had been in abeyance; but it now seemed to be the general idea, both of the North British Association and of the meter makers, as well as of the Standards Department of the Board of Trade, that if a standard were adopted it should be one generally suitable. The North British Association asked this Association to send representatives to a Committee to assist in carrying the matter through. It was certainly desirable that meter-unions should be of uniform size. But, so far as he could see, there appeared to be no opposition in the matter; and whether or not it was advisable for their Association to send a deputation all over the country, to spend money and time upon it, was a question upon which it might be better to hear the opinions of some of the members.

Mr. BOWER: Could that not be done by correspondence?

Mr. HARDIE: I should think that if the meeting be in harmony on the matter, it should not be necessary to send anyone—at least, that is my own feeling.

Mr. HERBERT LEES thought the Association ought to be represented in the matter. He moved that the President and Secretary be appointed to represent them.

Mr. WHYTE seconded the motion. He thought it would be a very great acquisition indeed, so far as he could see from what had taken place; and he did not think the meter makers were averse to the proposal, but rather in favour of it.

The motion was carried unanimously.

THANKS TO READERS OF PAPERS.

Mr. W. DOIG GIBB moved a vote of thanks to the readers of the papers.

Mr. J. H. COX (Sunderland) seconded, and the motion was agreed to.

ELECTION OF OFFICE-BEARERS.

The PRESIDENT intimated that the ballot had resulted in the election of the following gentlemen to be office-bearers during the ensuing year:—

President.—Mr. C. Dru Drury, of Sunderland.
Vice-President.—Mr. W. Doig Gibb, of Newcastle.
Auditor.—Mr. Herbert Lees, of Hexham.
Hon. Secretary.—Mr. J. H. Penney, of South Shields.
Committee.—Mr. T. Bower, of West Hartlepool, and Mr. W. Ford, of Stockton.

Mr. DRURY returned thanks for the appointment.

A vote of thanks was accorded to Mr. Holliday for his services; and the proceedings terminated.

The members and their friends afterwards dined together in the County Hotel—Mr. Holliday presiding. The toast of "The North of England Gas Managers' Association" was proposed, in a speech couched in a happy vein, by Mr. E. W. T. Richmond.

SOUTHERN ASSOCIATION.

EXCURSION MEETING, MAY 19.

This Meeting took place at Brentford, under the presidency of Mr. R. Beynon, of Torquay. By the kindness of the Directors of the Brentford Gas Company, the day was devoted to inspecting their works at Brentford and Southall. Undeterred by inclement weather, a numerous party of members put in an appearance at Brentford at the appointed time, and were received by the Engineer, Mr. J. Husband, who conducted them over the carbonizing part of the establishment, and explained the working of the inclined retorts and the carburetted water-gas plant. Brentford is a recognized show-place for the inclined-retort system; and it is unnecessary to describe how perfectly the work is done there. Every cubic foot of gas made on these works is produced by means of inclined retorts, supplemented with a Humphreys-Glasgow carburetted water-gas installation. Hence it is no wonder that Brentford is a place of pilgrimage for the progressive gas engineers of two continents.

After the inspection of the works, the visitors were hospitably entertained to lunch by the Directors, represented by Mr. W. Croxford, the veteran Secretary of the Company, and Mr. Husband, both of whom gave expression to the good feeling entertained by the Board for the Association. After lunch there was a brief interval of formal business; four new members being added to the Association. Their names are: Mr. Henry Morley, of Cardiff; Mr. J. F. Wicks, of High Wycombe; Mr. W. Bugby, of Southall; and Mr. H. D. Duesbury, of Broxbourne. This done, and the needful acknowledgments paid to the hosts, the party left in carriages for Southall, where more inclined retorts, as well as sulphate of ammonia plant, were inspected. A return drive to Richmond, for tea at the Star and Garter, finished a very full day.

MIDLAND ASSOCIATION.

EXCURSION MEETING, MAY 19.

Notwithstanding very unpropitious conditions of weather, the Midland Association members assembled in good numbers to take part in the Spring Excursion Meeting, which was fixed at Wellingborough, in order to afford an opportunity for inspecting the new retort-house now being fitted up at the works over which the President of the Association, Mr. J. T. Lewis, has control. There were some forty members and visitors present at the Gas Offices when at eleven o'clock the Chairman of the Wellingborough Gas Company (Mr. W. Woolston) offered a very hearty welcome to the Association on his own behalf and that of the Board. Mr. Lewis also expressed the pleasure he felt at finding that so many of his *confrères* had assembled to meet his Directors and inspect his works—most of them for the first time. Mr. J. S. Reeves, the Vice-President of the Association, acknowledged their indebtedness for the kindly way in which the members had been received.

Brakes were then requisitioned for a drive to the gas-works; and an hour was profitably employed in a close inspection of the new retort-house, which was rapidly approaching the stage when all the constructional details—apart from its eventual fitting up—could be fairly appreciated. The contrast between what this house will be and the present house and its predecessor (which is still standing as a curiosity of the olden times, back in 1833), excited much remark among the visitors.

The new retort-house and coal-store are one building 88 feet long and 64 feet wide between the walls. The retort-house contains six single benches of retorts, each containing eight 22 inch by 16 inch ⌓ retorts, with West's regenerator furnaces and settings. There is a stage-floor extending between the benches and the retort-house wall, composed of concrete arches supported by longitudinal and cross girders spanning between the benches and the walls. The surface of the stage-floor is covered with special paving bricks except near the benches, where the floor is of cast-iron chequered plates.

The benches are well braced together with H-steel buckstays, having cross tie girders above the bench for supporting the hydraulic, gas, and tar mains. The mouthpieces are fitted with self-sealing lids and fastenings arranged to suit West's stoking machinery; and they are well stayed to the benches by channel steel mouthpiece supports, set up in position by wedges attached to the buckstays. The hydraulic mains are of steel, and of U section; and the gas and tar outlet-valves are on West's latest principle. They are worked in connection with a special tar-vessel at the end of the retort-bench, and so arranged that the tar is taken away as fast as it is deposited.

West's manual charging and drawing machines, complete with steam-engine and coal-breaker, elevator, and overhead coal-hopper, have been installed in the retort-house, for the purpose of charging and drawing the retorts; the plant being similar to that which has been at work with success for some years at the Rushden and Higham Ferrers Gas-Works, where until recently Mr. Lewis was the Engineer and Manager. After the coke is drawn from the retorts, it is shot below the stage-floor through shoots leading into coke-waggons running upon rails. These waggons will convey the coke outside the retort-house, and tip it to the foot of the elevator, which will raise it to a screen and separate it into three sizes; the dust and small being received into overhead hoppers provided with doors for filling carts, and the large pieces being sent forward and stored in the yard.

The whole of the contract for the interior of the retort-house—comprising the stage-floor, regenerator retort-settings, and iron-work for the benches, together with the stoking machinery and coke-handling plant—was entrusted to West's Gas Improvement Company, Limited, of Manchester.

The inspection over, a temporary stoppage of the rain was taken advantage of for a drive through some of the main parts of the town, in order to afford an opportunity for the party to appreciate the rapid growth of houses of the better class in the locality. The drive ended at the Hind Hotel, where the members and a few local friends had been invited to lunch by the Directors of the Gas Company. At the close of the repast, Mr. Lewis, who was in the chair, gave the toast of "The Queen;" and the Chairman of the Company proposed "Success to the Midland Association of Gas Managers," to which the President, in fitting terms, replied. The only other toast submitted was that of "Prosperity to the Wellingborough Gas Company," by Mr. Reeves, and responded to by Mr. W. Wyldes, the Vice-Chairman, and by Mr. S. H. Kimbell, the Secretary

Before separating, the Hon. Secretary (Mr. C. Meiklejohn, of Rugby) introduced the only formal business needing to be transacted during the day—the confirmation of the minutes of the previous meeting, and the proposals for new members. The minutes were duly read and passed; and the following were elected members of the Association: Mr. Joseph Braithwaite, Manager of the Wrexham Gas-Works; Mr. Henry Shepherd, Manager of the Brownhills Gas-Works, near Walsall; and Mr. Frederick Lee, of the Hinckley Gas-Works.

A drive through some pretty country roads to the seat of the Marquis of Northampton was then commenced; and eventually Castle Ashby was seen from the distance through a rain-storm that continued with almost relentless severity till Wellingborough was again reached. The party went through the programme, however, regardless of the wet, and were certainly rewarded by seeing the lovely gardens and glass-houses for which the place is so justly celebrated, though not to such advantage as would have been possible had the weather not been altogether against outdoor exercises of any kind. High-tea was served in the village; and the return drive was made through Grendon.

The arrangements made by Mr. Lewis for the day's outing were admirable; and the trip was only marred by the wretched weather, and by a carriage accident on the way back, from which, unfortunately, Mr. Lewis sustained a fractured collar-bone.

MANCHESTER INSTITUTION.

EXCURSION MEETING, MAY 21.

Atmospheric conditions were more in favour of this meeting than those which prevailed when the Southern and Midland Gas Managers had their annual outings. Morecambe was the place chosen for the trip; and though bright genial weather—the one essential for the thorough enjoyment of a day at a seaside resort—did not favour the members, the rain was not a serious interference with the due carrying out of the programme of arrangements.

The party assembled at Morecambe shortly after midday, and were met by Mr. William Duff, the Manager of the Morecambe Gas Company, who was accompanied by his Chairman, Mr. W. G. Welch, and some other members of his Board. A visit of inspection to the gas-works was first made; and here the extensive reconstruction of the retort-house, and other enlargements now being carried out in nearly every department of the works, engaged the attention of the visitors for nearly an hour.

An adjournment was then made to the King's Arms Hotel, where the Chairman and Directors of the Gas Company entertained the members and a few friends to lunch—a courtesy much appreciated, and duly acknowledged afterwards by a hearty vote of thanks being passed to them, on the motion of Mr. Isaac Carr, seconded by Mr. R. G. Shadbolt, the Senior Vice-President of the Institution. The toast of "Success to the Institution" was given by Mr. Welch, and responded to by Mr. W. S. Haddock, the President.

In dull and threatening weather—which, however, did not turn to rain till just before the return journey was completed—the party then set off for a long drive to Caton, passing Lancaster, Halton, and Quernmore Park, and home by Skerton and the Carnforth Road to Slyne.

After high-tea at the hotel, the Hon. Secretary (Mr. S. S. Mellor, of Northwich) obtained the confirmation of his minutes of the previous meeting; and subsequently six members were added to the roll of the Institution—Mr. E. E. J. Anderson, of Ripon; Mr. G. S. Frith, of Frodsham; Mr. J. H. Parsons, of Buckley; Mr. F. Thorpe, of Colne; Mr. F. A. Winstanley, of Rotherham; and Mr. H. Worsley, of Golborne. The President, in a sympathetic speech, proposed a vote of condolence with the family of Mr. W. Smith, of Hyde, one of the founders, and also an Auditor, of the Institution, who had died on the previous Monday, after a brief illness. This was seconded by Mr. Shadbolt, and carried. It was reported that Mr. Mellor had received a letter from the Hon. Secretary of the North of England Association with reference to compensation to gas-works employees under the Employers' Liability Act; and the Committee of the Institution were to consider the letter, and later on advise the members further on the question.

Those who were not staying for the week-end at Morecambe left about seven o'clock, after further acknowledgments of their indebtedness to Mr. Duff and his Directors for their exertions to make the proceedings so successful as they had turned out.

NORTH BRITISH ASSOCIATION.

ANNUAL MEETING, JULY 28 and 29.

This Meeting was held in the Merchants' Hall, Glasgow—the PRESIDENT (Mr. T. Wilson, of Coatbridge) in the chair. There was a good attendance.

The PRESIDENT opened the proceedings by giving the members a hearty welcome.

THE COMMITTEE'S REPORT.

The SECRETARY (Mr. Robert S. Carlow, of Arbroath) read the report of the Committee, in which the following passages occurred :—

The Benevolent Fund in connection with our Association has not been drawn upon this year.

In terms of powers conferred on the Committee of the Association at the last annual meeting, to consult with the Councils of The Gas Institute and the Institution of Gas Engineers, and other Associations of Gas Managers in the United Kingdom, with the view of taking common action in connection with the adoption of a standard of meter-unions applicable to the United Kingdom, the Committee have to report that they instructed the Secretary to communicate with every Gas Managers' Association in the United Kingdom. To the circular which they issued, the Secretary received replies from a large number of the Associations, stating that they would be glad to co-operate with the North British Association in their endeavours to bring this matter to a successful issue, and would be prepared to attend any meeting convened for the discussion of the proposal. [The report contained a narrative of the action taken by the Committee, all of which has been recorded in this and previous volumes of "Reports."]

The Committee unanimously recommended that the name of Mr. G. T. Myers, late of Broughty Ferry, be added to the list of Honorary Members of the Association, seeing he was one of the originators of the Association.

Mr. J. B. TERRACE (Brechin) moved, and Mr. T. DOUGLAS HALL (Montrose) seconded, the adoption of the report, which was agreed to without remark.

THE MEMBERSHIP.

The SECRETARY submitted the following report as to the membership of the Association: Removed from the roll: Wm. Cheyne, Briton Ferry; Francis Chalmers, Stevenston; A. C. R. Dow, Tranent; John Hall, St. Andrews; Samuel Langlands, Coleraine; Alex. M'Lennan, Lennoxtown; Jas. Martin, Ladybank; J. M'Culloch, West Calder; Jas. Walker, Glasgow; and John Royal, Arbroath. Transferred to ordinary roll: David Easson, Maybole; and Alex. Masterton, Edinburgh. The membership, after these changes, consisted of: Ordinary members, 149; extraordinary members, 58; associate members, 11; and honorary members, 8—a total of 226. The following new members were added to the roll: Ordinary members—Jas. Baxter, Berwick-on-Tweed; Edwin Davis, Lochwinnoch; C. S. Gillespie, Wick; J. B. Scott, Innellan; Thomas Wm. Ward, Stevenston. Extraordinary members—Robert Grant, Glasgow; T. Cuthbert Stewart, Glasgow; Archibald MacKay, Edinburgh. Associate member—George Christie, Arbroath. Honorary member—George T. Myers, late of Broughty Ferry. The total membership now numbers 235—the same as it was last year.

THE ANNUAL ACCOUNTS.

The accounts showed, in the General Fund, an income of £145 18s., and a balance of £37 13s. 9d.; in the Benevolent Fund, a charge of £235 14s. 7d., which included a deposit receipt for £200, and annual subscriptions amounting to £28 13s.; in the Research Fund, a charge of £83 11s. 3d., and £65 on hand.

Mr. J. NAPIER MYERS (Saltcoats) said he should have had great pleasure in moving the adoption of the accounts but for one item in the Benevolent Fund account. On the discharge side, the only entry was the Secretary's allowance, which he thought was too high, and moreover should not be debited to the Benevolent Fund. To mark his dissatisfaction with the arrangement, he would move that the Secretary's allowance be reduced from £8 8s. to £8.

The PRESIDENT thought it would be a great pity if their reports were not to be approved of because of the difference of 8s. The Committee had duly considered the matter; and he might explain that the £8 8s. covered expenses connected with the issuing of circulars and other matters.

Mr. D. VASS (Edinburgh) said he had much pleasure in moving the adoption of the accounts, which, he thought, were highly satisfactory. There was no doubt that the charge against the Benevolent Fund, which had been referred to, looked large; but it was very much a question of book-keeping.

Mr. R. B. MAIN (Glasgow) seconded the motion. He thought Mr. Myers was under a misapprehension about the charge to the Benevolent Fund. He did not know of any Association in Glasgow, or anywhere else, where the expenses of the Secretary were not charged against the funds. He thought the charge was perfectly legitimate, and should be allowed to remain.

The motion for the adoption of the accounts was then put and agreed to.

THE MURDOCH MEMORIAL FUND.

Mr. J. M'GILCHRIST (Dumbarton), the Convener of the Sub-Committee in charge of the Murdoch Memorial Fund, said he had great pleasure in submitting the final report as to the fund. Since their last meeting, they had sent a copy of the book "Light Without a Wick" to all the members of the Association, to all the Public Libraries of the United Kingdom, to all the Universities and Colleges in the United Kingdom, to the leading Professors, to all the newspapers in Scotland, and to all the Presidents and Secretaries of Gas Associations in the United Kingdom; and, after paying every charge against the Murdoch Memorial Fund, and the accounts having been audited by Mr. R. B. Main, there was a sum of £11 12s. 10d. in favour of the fund. This amount, along with a balance of some hundred copies of "Light Without a Wick," the Sub-Committee suggested might be handed to the Committee of the Association, to be dealt with by them as they thought fit. Seeing that there was a long programme before the meeting that day, he would not take up their time further than just to state that he had had great pleasure in working in connection with the gentlemen who had acted on the Sub-Committee. They had the late Mr. John M'Crae, of Dundee, and Mr. David Terrace, now of Middlesbrough, who rendered very great assistance in carrying out the objects of the fund. They also had Mr. Alexander Bell, their Past-President, who was now the Chairman of the Sub-Committee. He was pleased to say that the newspapers in the country had very favourably criticized their publication of the work "Light Without a Wick;" and he had had hundreds of testimonials from other sources, all indicating that they had done the right thing. He was pleased to think that, among the other things which they had done in connection with the Murdoch Memorial Fund, they had been able to put a bust of the great Scotsman, Murdoch, along with his brother kings and poets, in the National Valhalla in the Wallace Monument. He did not know that he could add anything further; but he wished to thank all the members for the kind way in which they had assisted him in the work, since the year 1882. He moved the adoption of the report and the recommendation of the Sub-Committee.

Mr. ALEX. BELL, sen. (Dalkeith), seconded the motion. Mr. M'Gilchrist, he said, had kindly mentioned that he was Chairman of the Sub-Committee. Well, he was sorry that he should be in that position, because he was only a simple stopgap, and had done nothing for the fund, in any way. He had simply filled up the position held by the late Mr. John M'Crae. Therefore, in anything he might say he was not seeking any glory or praise to himself—Mr. M'Gilchrist was the man. Upon him all the glory lay. It was nearly twenty years since the fund was started; and Mr. M'Gilchrist had all along been indefatigable in the working of it. As this was the last meeting at which the subject would be considered, he thought the least they could do was to render Mr. M'Gilchrist very hearty thanks indeed for all his labour. The other members of the Committee had, no doubt, done their fair share of the work; but Mr. M'Gilchrist alone had carried it through. He therefore considered that he deserved the thanks of the Association and of the gas industry in bringing forward their compatriot and the initiator of their industry. He proposed that Mr. M'Gilchrist should have a very hearty vote of thanks for his labours.

The PRESIDENT said that, as an Association, he thought that their thanks were also due to the Sub-Committee for their labours in getting up the memorial; and also for handing the balance of nearly £12 over to the Association. If the proposal met with their acceptance, he was quite certain that the money would be safe in the hands of the Committee.

The report was adopted, and the vote of thanks was accorded.

THE PRESIDENT'S ADDRESS.

The PRESIDENT then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—Before beginning my address, allow me to thank you most heartily for the honour conferred on me by appointing me President of this Association. I shall do my best in conducting the business of this meeting so that it may not be behind those which have preceded it. We are promised some valuable papers to-day; and I will, therefore, not detain you with a long address, believing that a practical paper followed by a profitable discussion is of much more value to the practical manager.

In selecting a subject for my address, I have experienced some difficulty, as all the latest discoveries and improvements are so well made known through the columns of our trade journals that it would almost be superfluous on my part to attempt to enlighten you further on them. I should just like to make a few comments in a general way on one or two matters which affect gas managers and the industry they represent.

Some years ago the Board of Trade, in fixing the relative value of electricity and gas, allowed 10 units of electricity as an equivalent for 1000 cubic feet of 15-candle gas; but since then it has been discovered that it takes fully 13 units instead of 10. Electricity is a splendid light, and well suited for public and private lighting; but at the same time it is an expensive light, and may only be looked upon as a luxury.

I dare say many are surprised that electricity succeeds as it does. But this is not to be wondered at, when it is considered that quite a number of public boards are willing to encourage enterprise, whatever the cost—whether from public-spiritedness, or from the fact that the money does not come out of their own pockets, I will not say. I happen to know a case where a Town Council ordered the erection of eight electric lamps, and contracted for a supply of electricity at the rate of £21 5s. each, for the lighting season—or a total of £170. These eight electric lamps took the place of 35 gas-lamps at £2 each per season, or a total of £70. Thus the Town Council referred to, who were supposed to be practising economy in the interests of the ratepayers, paid out for electricity alone the sum of £170, while for the sum of £70 they could have had the same area lighted with gas.

In the case of private lighting, it takes 13 units of electricity, as I have already said, to give a light equal to 1000 cubic feet of 15-candle gas, using a batswing or union-jet burner. It will, therefore, take 21 units to equal 1000 cubic feet of 25-candle gas—this being the average quality of Scotch gas. So that it will be seen, if electricity is taken at 5d. per unit, and Scotch gas at 2s. 11d. per 1000 cubic feet (both fair average prices), the cost of electricity as compared with gas is three times as great; and, further, if the new Welsbach incandescent burner, which requires no funnel or chimney, is what is claimed for it—viz., that with an hourly consumption of 2 cubic feet of gas it gives a light equal to 50 candles—it is clear that, by using gas with this burner, the luminosity of English gas is increased some eight times, and Scotch gas a little over five times.

A great deal has been said of acetylene gas as an opponent to coal gas; but this is mere talk, as acetylene is not likely to compete successfully with coal gas as an illuminant on anything like a large scale. To begin with, like electricity, it is much more expensive, and is attended with a considerable amount of trouble and danger—being a very explosive gas. Oil is, in my opinion, the greatest opponent we have; and it is largely used by the artizan classes. Though it is a much cheaper illuminant than electricity or acetylene, it is also attended with too much trouble and a great amount of danger. The reason that oil commends itself so largely to the classes mentioned is because of the possibility of purchasing small quantities at a time; but this has been effectively provided for in the gas industry by the introduction of prepayment meters. With gas-engines, stoves, and fires, brought as they are to such perfection, gas has nothing to fear either as a cheap illuminant, motive power, or heat producer; and it is sure to hold its own against all comers.

I should like to say a word or two regarding the treatment of workmen in gas-works. In many cases, the workman or stoker begins on the 1st of January and finishes on the 31st of December —never getting a holiday. Not even on the Sunday is he allowed to rest. It would appear that slavery is not yet abolished; and the time has arrived when we, as managers, should put an end to it, so far at least as gas making is concerned. With a little judicious planning, in the majority of gas-works, the stokers could be relieved from duty at least for twelve hours on Sundays. This would cost a little extra, as the furnaces or producers have to be kept heated. But it will be repaid by obtaining a better class of workmen and a larger amount of work done during the rest of the week.

I may here state that in Coatbridge, we have had no stoking on Sundays from six o'clock in the morning till six o'clock in the evening during the past eighteen years, with the very highest results; also all our workmen are allowed a day off at the New Year and eight days off during the summer as holidays, and are paid full wages for these holidays. With all this, our stoking wages do not exceed 1s. 6d. per ton of coal carbonized. The Scotchman is famous all over the world for keeping the Sunday (and all he can lay hands on), and I hope that we, as gas managers, may do our best to maintain the Scottish reputation.

Another matter I should like to mention, which affects very much our position and credit as gas managers. It is the aim of every manager, to sell gas of good quality at as cheap a price as possible. To do this the raw material must be procured in the cheapest market, and economy exercised in the manipulation of same, both in the carbonizing of the coal, and in cooling and purifying the gases, while every care should be taken to sell as much gas as possible. In looking over the returns of our Scotch gas undertakings, I observe that the unaccounted-for gas varies from 5 to 20 per cent. Now I do not think that the leakage in any well-conducted concern can possibly amount to anything like 20 per cent. The possibility is that something else is at fault—either the cooling or purifying plant is insufficient, causing the gases to be registered at the station meter at a very much higher temperature than they are likely to be at the consumers' meters, and which will account in many instances for a considerable difference. It may be that the consumers' meters are not being attended to with water in the case of wet meters, or getting out of repair, as is often the case with dry ones. The attention to consumers' meters is a very important matter, and should have first consideration. In coal-mining districts there is a considerable leakage caused through subsidences of the ground; and these towns so situated are always more liable to have a higher percentage of unaccounted-for gas than those removed from coal fields. While a gas manager may be striving hard, and doing his best to make the concern a success, and attain for himself a name, he is often prevented by members of his committee stupidly interfering. It is amusing to witness the performances of some of these individuals. It may be the greengrocer or billposter, whose knowledge of things in general outside their own small business is not very great, sitting in all the pomp which characterizes such a class of men, and all the dignity befitting a judge, dictating to the manager, how to conduct the affairs of a gas-works, while the manager may have spent the best of his years or perhaps a lifetime in studying his business. If there was less of such interference, things would be better managed, and the public get a cheaper light.

I know of several cases where gas undertakings have suffered very considerably through the wanton interference of certain members of the gas committee. A corporation or company, in selecting a manager, should appoint a thoroughly competent and trustworthy person, paying him a proportionate salary, and should then leave the management in his hands; and the manager, I would say for his own credit, will do his very best. We, as managers, should resent such interference, especially if we are fully convinced that we are quite competent, and trustworthy enough, to be left in full charge of the management; and we should take up a strong position accordingly. I believe that this sort of treatment is much more common in small than in large concerns. The committees of the latter are usually composed of business and commercial gentlemen, and with men of sound business training one usually gets good common sense.

One other matter I should like to mention before finishing—viz., insuring against accident under the Employers' Liability Act, which came into operation at the beginning of this month. It is very essential for small concerns to cover themselves against all risks. The cost of so doing, even at 12s. 6d. per cent. of the wages paid, should not be considered too heavy a burden, and it will relieve the company or corporation of great responsibility. In the case of larger concerns it is not so essential, as provision is usually made in their Acts of Parliament, to lay aside a reserve or insurance fund with which to meet such contingencies.

I thank you, gentlemen, for the patient hearing you have given me; and I hope my remarks have not been uninteresting.

Mr. W. EWING (Hamilton) proposed a hearty vote of thanks to the President for the address that he had delivered. There was one remark the President made, with regard to gas committees, to which he might refer, if it were not invidious of him to make any remark upon it; but he had always found that with a good convener, the gas manager always got justice in the end.

The PRESIDENT returned thanks.

READING OF PAPERS.

Mr. W. EWING (Hamilton) read the first paper, entitled—

RETORT-SETTINGS, AND PRACTICAL RESULTS OBTAINED.

Our President having selected the title of "Retort-Settings, and Practical Results Obtained," as a subject suitable for consideration at this meeting, and one calculated to create a profitable discussion and a helpful exchange of ideas, I consented, after some hesitation, to do what I could in preparing a paper on the lines indicated. I purpose giving you a short description of the condition in which I found the gas-works of the Hamilton Corporation on taking over the duties of Manager there, in the autumn of 1892, and the means I adopted to overcome the difficulties which immediately presented themselves.

Soon after being installed at Hamilton, I found that the condition of the works had been reported upon by an expert prior to my installation. This report stated that the plant was then at its utmost limit of production, and that the plant and buildings generally were rather antiquated, and in need of repairs and extension. The retort-benches then contained in all 57 retorts. These were all on the direct-firing principle; and great difficulty had been experienced, during the winter previous to my taking up office, in supplying the growing demand for gas during the maximum consumption. This, however, was ultimately successfully overcome by building settings of retorts on a simple generator principle in room of the old settings removed, without extra cost. The maximum storage capacity was, at that time, 255,000 cubic feet, though at times the available capacity was as low as 200,000 cubic feet, on account of the water leaking from the gasholder tanks through cracks caused by underground workings. From the same cause, and notwithstanding constant repairs, the main pipes and services were in a very bad condition—leaking all over the town, and causing the leakage or unaccounted-for gas to assume the enormous figure of 22·5 per cent. of the annual production.

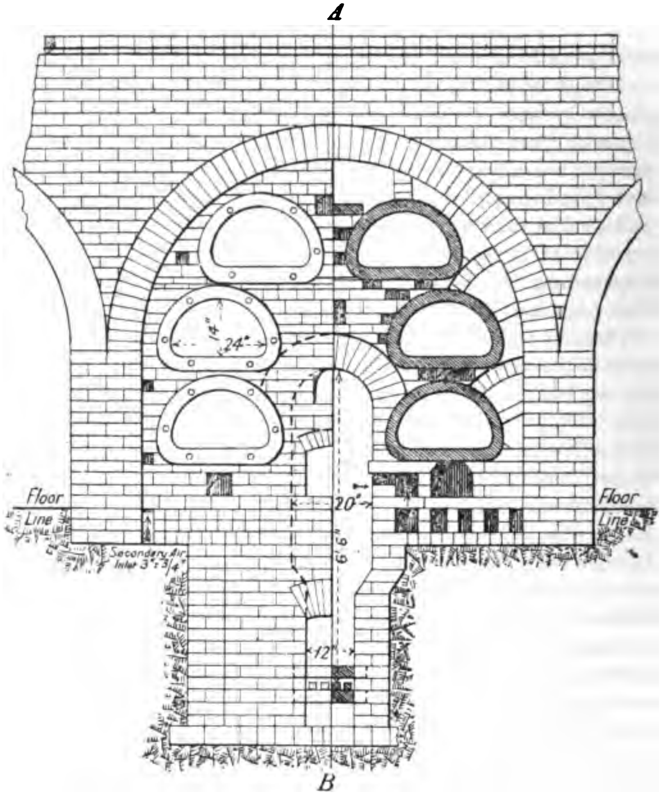
In works so much congested as ours, difficulties were the order of the day, and were, of course, peculiar to the works and the locality of the situation of the plant in which they had their existence. The Convener and members of the Gas Committee offered me every support in combating these difficulties, with the result that during the winter of 1892-3 we found ourselves in, comparatively speaking, still water, and this without any capital expenditure, which had been strongly advocated at the time, but at the cost of much physical energy. A large scheme of extensions was under consideration at the end of 1891; but when my Committee found how I had tided over the following winter and met the increased demand for gas, having regard to the favourable results obtained by the substitution of a simple generator setting of retorts, they decided to delay, for a time at least, any further consideration of extensions.

The simple generator setting of retorts which I have referred to, and which was designed to meet special circumstances, is shown by the drawings. They were introduced into each oven (excepting two settings of twos) as the old settings required renewing; and the cost for material and labour being practically the same as that required for the older systems, no extra expenditure for the same number of retorts was entailed—the work being done by our own employees. Into each oven that formerly held only three and four retorts I introduced five and six. This was accomplished by reducing the floor to the level shown on the drawings. The retorts were of the same sectional area as those formerly used, but were 6 inches longer. The dimensions of the old retorts were 8 feet long by 24 in. by 14 in., and of those introduced 8 ft. 6 in. long by 24 in. by 14 in. This additional 6 inches in the length of the retorts necessitated their projecting beyond the front walls of the settings; but this had the double advantage of giving one a larger carbonizing area, and consequently greater yield of gas per retort, as well as practical immunity from choked ascension-pipes, which pleasing circumstance it has always been my lot to enjoy. In my experience, I have found that if the ascension-pipes are of ample bore, and fixed so that they are a few inches off the perpendicular, the condensable tarry matter runs down one side of the pipe, instead of spreading round its whole area, and thereby prevents choking when high heats are in use.

When all the old direct-fired settings had been replaced by those of the newer design on the generator principle, we found that we had, in the same space, added an additional 25 retorts; thus having 82 available retorts, as against 57 hitherto. The productive capacity was raised by this means from 330,000 to 750,000 cubic feet; and this for the trifling cost of £150 for additional retorts. My object in introducing this system of retort-setting was, at the outset, to be able to maintain higher heats, increase the yield per ton, and save fuel; but I also found that with the increased number of retorts in the same ovens I could produce 100 per cent. more gas. The working results came as a pleasant surprise to my Committee, who were deeply interested in the arrangements, and who awaited with much interest the result of the first year's working.

For manipulating these settings of retorts, the usual care is required in regulating the dampers, secondary air, and steam. The regulation is done gradually, and the openings increased till the required amount of each is obtained. The setting then requires no further attention, excepting the clinkering process, which is occasioned once in every eight or ten days, and the feeding of the producer with hot coke direct from the retort. I have found that the best results are obtainable with a depth of from 3 to 4 feet of coke in the producer. The furnace bars have a hole at the end and project 3 inches in front of the furnace door in the producer pit. They are shaken up every eight hours, after which the top door of the producer is opened, and the remaining clinker and coke are pushed down on to the bars and allowed to settle, so that no space is left between the bottom of the coke in the producer and the furnace bars. The steam-jet underneath the producer bars makes the clinker very

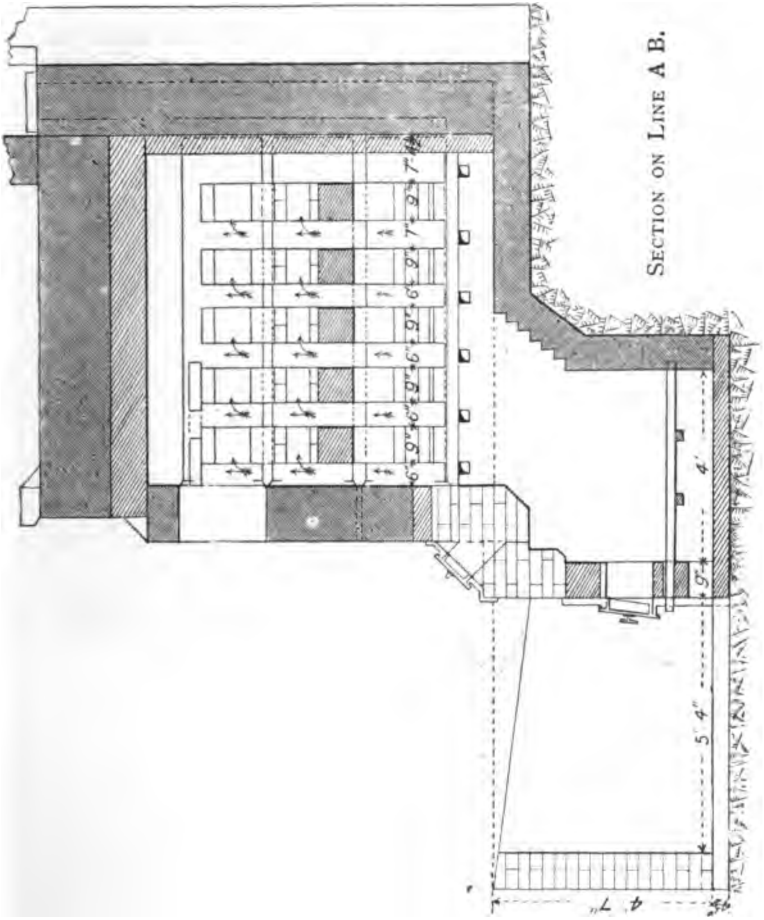
FIGS. 6 TO 10.—GENERATOR SETTING OF RETORTS AT THE HAMILTON GAS-WORKS.



ELEVATION. SECTIONAL ELEVATION.

friable; and the greater part of it is reduced to powder by the action of shaking the bars. The secondary air is admitted at the front of the retort-bench, immediately underneath the bottom retorts, through a slot in the brickwork communicating with five graduated secondary air flues to the producer, where it meets the producer gases in the combustion chamber, and at once combines with them. The products of combustion are first led upwards through the setting, then down both side flues simultaneously; making their final exit along the flue underneath the bottom retort, and thence up a vertical flue in the wall behind the setting to the main flue situated on the top of the bench. I

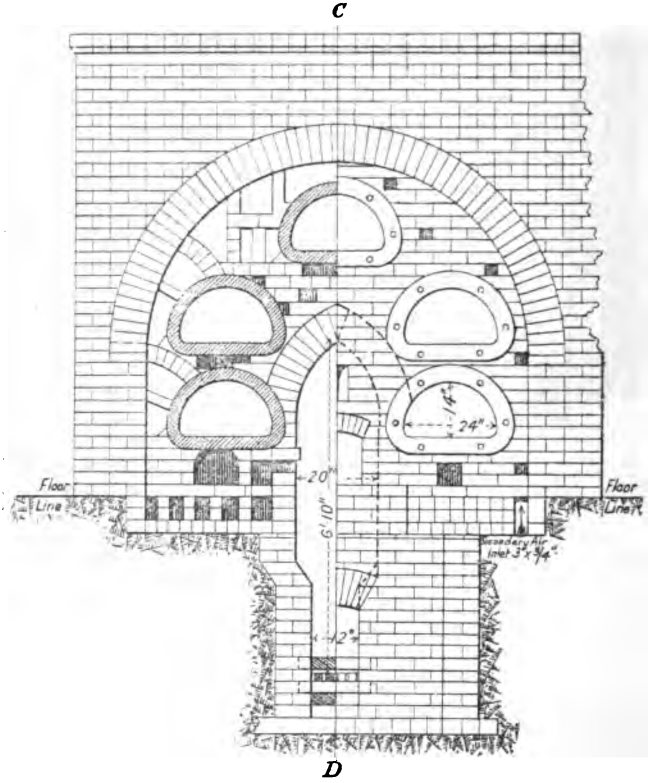
FIGS. 6 TO 10.—GENERATOR SETTING OF RETORTS AT THE HAMILTON GAS-WORKS.



have always found this setting to give equal heats throughout the oven; any local heating being overcome by an arrangement of dampers and slip bricks inside the setting, which are either opened or partly closed to obtain the desired result.

The slot in the brickwork, through which the secondary air passes, is regulated by means of a brick; and I find that for a setting of five or six, with a draught on the chimney equal to 1 inch of water, an opening 3 inches by ¾ inch is suitable.

It was not till 1894-5 that we derived the full benefit of these settings; but during that year they did good work, giving us practical proof of their utility and amply justifying their adoption. The make of gas per mouthpiece averaged from 8500 to over 10,000 cubic feet; and the fuel account was from 16 to 20 per cent. of the total coke made—assuming the yield of coke from local cannels to be 11 cwt. per ton of coal carbonized. The yield of gas per ton of coal carbonized was, for some, about 11,000 cubic feet from local third-class cannels, and which the printed form of analysis showed as giving 10,860 cubic



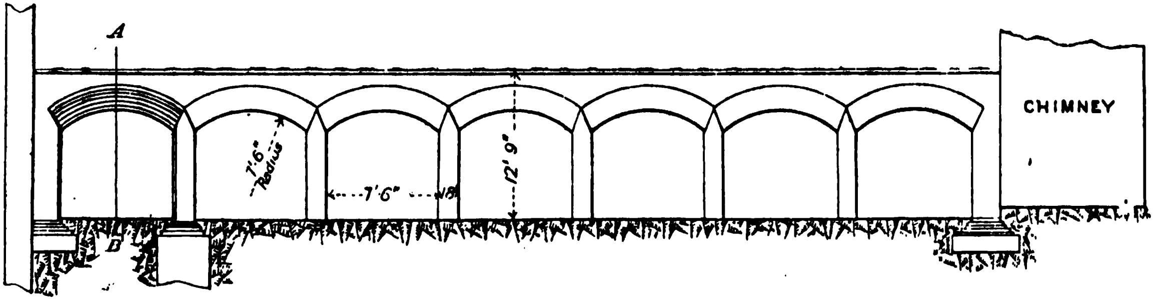
SECTIONAL ELEVATION. ELEVATION.

feet per ton. To ascertain the actual yield of these cannel coals with high heats, I made three different tests on a working scale, with a resulting average yield of 12,300 cubic feet per ton, the coals being carefully weighed. After a few months' trial with very high heats, we found a great difficulty in getting the tar to flow freely from the foul main, owing to the hydraulic main being so near the top of the bench—there being only 12 inches space between them. The tar contained in the hydraulic main began to distil, and so caused no end of trouble in necessitating the drawing of the thick tar from the drip-box by hand, and then putting it into open barrels. This caused us to exercise great care to prevent the complete solidification of the contents of the hydraulic and foul mains. This was a most hazardous and disagreeable task; and to prevent it, and a probable stoppage of the works, we found it safer to make about 10,000 cubic feet per ton.

The table of working results [p. 194] shows an improvement in the returns from 1893; but the greatest improvement in results is from 1894 to 1898, for during these years I had practically the full use of the new settings. I must also include the year 1891-2, as during the whole of this year direct-fired settings were in use. Only one half of the following year (1892-3) was under my management. It will be noticed from this comparison that the make of gas increased from 61,750,000 cubic feet in 1892 to 102,000,000 cubic feet in 1898; and I am much pleased to say that during the current year we shall be paid for 100 per cent. more gas than in 1892. This, in a sense, is largely due to the great reduction in the leakage account, which, after several years of downright hard work, has been reduced from the unenviable figure of 22·5 per cent. in 1892 to about 10 per cent. for the current year. At present our output of gas is 25 per cent. more than it was this time last year; and I calculate that our make of gas this year should be anything between 110 and 120 million cubic feet. The returns for tar and liquor have been variable—ranging during the past four years from 55·65 to 70·95 gallons per ton of coal used. The fuel account, too, has been variable; but the average, after making allowance for shale and the firing of boilers, is 21 per cent. of the total quantity of coke made.

Early in 1895, I reported to my Committee that I could not take the risk of carrying on the works another year without certain extensions, including a new gasholder, to be completed ere we entered into another winter—the maximum output of gas having reached 2½ times the available storage capacity of the holders. I was instructed to report and give a plan and probable cost of the extensions. The proposals were passed in Committee, and fought bravely for in Council, but were ultimately sent back for further consideration. However, during the following summer, after a delay of several months, the scheme of extensions, as originally sketched out by me, was finally passed, and the work proceeded with, but too late to be of service for the ensuing winter; and, in consequence, the loss all round was pretty heavy, and the working results considerably reduced. The result of this long delay may be seen in the table.

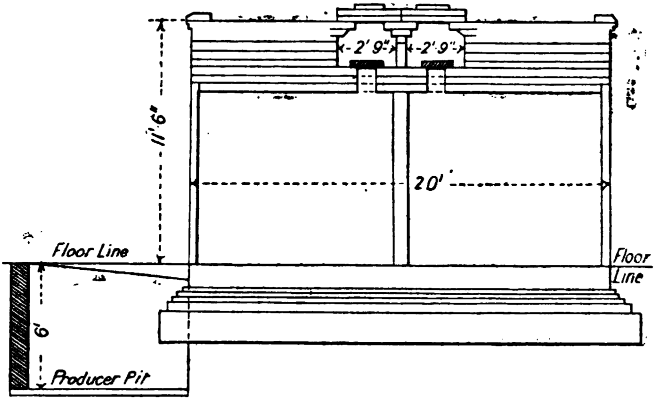
The winter of 1895-6 came thus unprovided for, although a strong effort was made to get part of the plant ready. One-third of the available retorts were exposed to the weather without any roof covering whatever; but, notwithstanding these inconveniences, we were successful in supplying the demand for gas during the Christmas and New Year weeks—including the record maximum output of 703,000 cubic feet—and this



ARCHES FOR 112 RETORTS.

with only an available storage capacity of 230,000 cubic feet. This was an anxious time, as you may suppose; but it was overcome without any inconvenience to the public. Seeing that these old benches of retorts were condemned as inadequate for the requirements of 1891, it was but natural to expect them to be somewhat dilapidated, and very unprofitable to work in 1896-7, although as much gas has been made in these latter years in the same ovens as in the thirteen years previous to 1891.

To meet the requirements of a rapidly-growing consumption, I designed a double bench to contain 112 retorts—14 settings of eights—on the same generator principle as those already in use. A rough outline sketch of this bench is shown here, which cost, exclusive of all ironwork, £13 per mouthpiece, or £22 per mouthpiece inclusive of ironwork, complete. A few settings in the old bench having been in use, together with the settings of the new bench, I had no opportunity of comparing the new with the old settings. However, within the past few days, I have had two settings of eight in the new bench working side by side, with good results. They are making about 10,000 cubic feet of gas per mouthpiece per 24 hours with a return of 10,000 cubic feet per ton of coal carbonized and a fuel account of from 18 to 20 per cent. At the time of writing, our daily output averages from 150,000 to 200,000 cubic feet, one-half of which is sent out during the daytime—*i.e.*, from six in the morning till six at night



SECTION ON LINE A B (ENLARGED).

The cost of carbonizing per ton of coal, which includes breaking coal, labour, firing boiler, and looking after governors and

Comparison of Working Results at the Hamilton Corporation Gas-Works from 1891-2 to 1897-8.

Year.	Coal Used. Splint, Cannel, and Shale.	Cost of Coals.	Cost per Ton Used.	Gas Made.	Total Received for Residual Products.	Total Received for Residual Products per Ton of Coal.
	Tons.	£	s. d.	Cubic Feet.	£ s. d.	s. d.
1891-2	7,515	5099	13 7	61,738,900	2319 8 2	6 2·06
1892-3	7,449	5315	14 3	70,058,500	1418 14 6½	3 9·72
1893-4	7,296	3087	8 5	71,876,000	1578 11 2	4 3·90
1894-5	7,772	3252	8 4	80,623,100	2607 8 2¼	6 8·64
1895-6	10,032	4323	8 7	95,637,800	2361 7 1½	4 8·49
1896-7	10,803	4150	7 8	105,000,000	2424 18 11	4 6·13
1897-8	10,606	4375	8 3	102,018,900	2181 9 0½	4 1·60

Year.	COKE.					TAR AND LIQUOR.				SPENT LIME.		
	For Sale but not including that Used in Boiler.	Saleable per Ton of Coking Coal.	Sold.	Rate.	Amount Received.	Due to Year and Sold.	Rate per 100 Gallons.	Amount Received.	Quantity per Ton of Coal Used.	Sold.	Rate.	Amount Received.
		Cwt.	Tons.	s. d.	£ s. d.	Gallons.	s. d.	£ s. d.	Gals.	Tons.	s. d.	£ s. d.
1891-2 .	The average amount of fuel used from 1894 to 1898 was 21 per cent. total production of coke.	Does not include coke used for firing boilers.	1353	5 10	396 8 11½	372,965	9 9 10 1	1893 12 3	49·63	518	1 1	23 7 11½
1892-3 .			1146	5 7	318 19 9½	385,657	10 1 3 7	1059 3 5	51·77	668	1 3	40 11 4
1893-4 .			2021	5 3	533 5 0½	433,228	3 7 4 9	1009 19 0½	59·37	615	1 2	35 7 1
1894-5 .	3312	8·10	3067	5 9	883 4 10½	546,458	4 9 6 3	1644 19 0	70·30	1035	1 6	79 4 4
1895-6 .	3441	7·54	3140	5 1	799 9 1½	558,313	6 3 5 0	1491 3 4	55·65	943	1 6	70 14 8
1896-7 .	3636	7·34	3086	4 9	738 13 9	665,947	5 0 4 9	1626 4 1½	61·64	802	1 6	60 1 0½
1897-8 .	3935	8·27	4380	4 2	910 17 7	752,581	4 9 3 0	1225 3 2	70·95	617	1 6	45 8 3½

exhausters, runs from 1s. 8d. per ton, when the men are working full, to 2s. at other times, when the men are not so fully employed stoking. The cannel coal is now delivered at a level higher than the retort-house floor, and is always brought forward to the face of the bing by making the horse and cart travel along the top of the coal, when it is tipped over the face towards the floor. I have found that the coal can be broken ready for the retorts at something like 1½d. per ton against the handling and breaking of coal, which was the case formerly, at a cost of from 4d. to 6d. per ton.

This year's price for residuals is the lowest on record; but, notwithstanding this, and considering the extra facilities given by the new plant, and that corporations are supposed to sell gas at cost price after paying the interest on loans, and allowing a reasonable sum for depreciation, I am very confident when I say that we are in a position to sell gas at 1s. 9d. per 1000 cubic feet, and meet all the necessary obligations. This would then put us in the position of selling gas of 23 standard candles at 0·91d. per candle.

It is not to be inferred from these increased results that the duties of the workmen have also been increased; and although the number of employees is less than formerly, their work is now much less fatiguing, their working hours are reduced, and their pay is increased. Good working results can only be obtained by careful and judicious management, and by strict personal supervision and skilled assistance in every department of the works, without which all the combined energy of the very best form of generator or regenerator settings and apparatus would be of no avail, and could not be expected to give results that were entertained, but neither attempted nor catered for. Good results, gentlemen, are within the province of every one of us, and should be diligently and thoughtfully sought after.

Discussion.

The PRESIDENT said he was sure the members were all very much indebted to Mr. Ewing for his valuable paper, which must have cost him a great deal of time to prepare. He thought they would all be able to learn a lesson from Mr. Ewing, who talked of getting 11,000 cubic feet of gas per mouthpiece; at Coatbridge they were well satisfied if they got 9500 cubic feet.

Mr. J. NAPIER MYERS (Saltcoats) understood Mr. Ewing to say that the secondary air was taken from underneath the last flue of the side retorts. Did he not think it was a weak, or faulty, arrangement to heat the secondary air by the last flue under the bottom retorts? Did it not tend to rob the floor of that retort of the heat carried into the furnace? He should like to hear what Mr. Ewing had to say as to the arrangement.

Mr. W. **Carr** (Stalybridge), on being invited by the President to take part in the proceedings, expressed his pleasure at being present and in speaking upon the paper. Gathering, as nearly as he could, the results the author had achieved, he must say that they were particularly good. He agreed with the previous speaker in regarding the setting as very faulty in principle. Whatever the results obtained from it, it did not strike him as being at all a scientific setting. He thought the weak point was the one referred to by the previous speaker—the place where the secondary air supply was taken. He listened very attentively to the paper, and gathered from it that Mr. Ewing was just persevering with the same setting of retorts that he put in at first. Probably, from the good results he obtained he felt warranted in doing so; but he (Mr. Carr) should have thought that, having accomplished so much with so little, he would have tried to improve upon the matter, and have gone a little farther. Like Mr. Ewing, when he went to Stalybridge early in January some two or three years ago, he found that all the retorts were in use—every mouthpiece there was in the place—and yet they could not keep the gasholders up. They had to work at reduced pressure for fear of the holders landing. During the following summer he took out 92 mouthpieces. He did not try to utilize the arches as they were, because some of them had seven retorts in them, with direct firing. He took out the whole of the bench, and erected a new installation of regenerative furnaces, on what he considered to be the most scientific principle; and he put in 144 mouthpieces in place of the 92 taken out. But in order to do this he had to put nine retorts in every setting—three tiers of three each. During the past winter, he was unfortunately compelled to be away from the works a great deal. He might mention that last summer he started to take the second half to pieces, and then reconstruct it; but, owing to his illness in the autumn, he was unable to complete the work. He was left with 70 of the retorts which should have been done away with; and he had to "face the music" with the 144 new retorts erected on the regenerative principle. The men managed to get through the winter very easily, without requiring to put the old retorts to work. They had not been able to accomplish the extraordinary result of getting 10,000 or 11,000 cubic feet of gas per mouthpiece; but he did not feel at all discouraged by that, because he did not think the make per mouthpiece was a true criterion of the worth of a setting. He could get a great deal more per mouthpiece than he did; but he thought it would be at the sacrifice of economy in working. Of course, his retorts were not so large as those of Mr. Ewing; they were 22 inches by 14 inches. But, even so, he did not, under any circumstances, consider it was wise to go in for a very large make of gas per mouthpiece. He did not find that those people who claimed very large makes per mouthpiece—Mr. Ewing, of course, excepted—produced very cheap gas. But Mr. Ewing had done so, and had put in what appeared to him (Mr. Carr) to be, to the best of his recollection, the cheapest setting of retorts he had ever heard of; for £22 per mouthpiece for retort-settings, with ironwork included, was, he thought, exceedingly low. His (Mr. Carr's) brother claimed to have done it at £26 per mouthpiece; and the installation which he himself put in came to a fraction under £27. Mr. Chester, in a paper he read before The Gas Institute in 1894, spoke of a setting coming out at £46, which he considered a very low figure. This included the flooring and all other matters. His own did the same. Outside of the flooring, he did not see how the retort-mountings could be much more extensive in the one case than the other; and as Mr. Ewing had succeeded in doing the work for £22 per mouthpiece, he had certainly given them something to think about—as to how they were to reduce the cost of their settings.

Mr. J. M'Gilchrist (Dumbarton) said he should be glad if Mr. Ewing would tell them exactly what he included in the £22. It seemed such a very low sum, that he was afraid the price of the excavation, or work of that kind, must have been left out. However, he thought, after what they had heard Mr. Ewing say, they might give Hamilton the very top place in connection with the cheap and economical manufacture of gas. He thought they might call it the Widnes of Scotland.

Mr. D. Vass (Edinburgh) thought that Mr. Ewing mentioned one little point, with reference to the heats being so high that they caused pitching in the main, and had compelled him to lower the heats. He thought it would have been a great advantage if Mr. Ewing had been able to retain his high heats and also do away with the pitching. He had had some experience of it during the past winter; and he was glad to say he had got over it by putting in a sort of cushion of sand on the top of the bench. By this means the heat was kept away from the hydraulic main, and they were able to maintain their heat in the ovens. It was only a little experiment on their part; and he was glad to say it had been successful.

Mr. A. Wilson (Perth) said he was in a like position with Mr. Ewing in having these furnaces in use at his own place. He supposed Mr. Ewing was of opinion that this was the best system of firing, and had pinned his faith to it, as he was contemplating the erection of a bench of 112 retorts upon the same system. He (Mr. Wilson) could understand his adopting such a method of ring in a case of emergency, as he had to do the same thing himself. They were in the unfortunate position of being very much cramped for room, and were removing their works; and so he found it necessary to adopt some other system of firing, to enable them to go on till they had the new works erected. He therefore adopted the system Mr. Ewing had advocated. But he did not like it at all. He would as soon see it out in the ash-heap, if he could afford it. He had had a little experience of open furnaces, and also of regenerative ones; and he could assure the members that, in his opinion, the regenerative was not only the best in every way, but the cheapest in the end. It might cost a little more to begin with, but it was really the cheapest process in the long run. Mr. Ewing stated that his carbonizing wages were something like 1s. 8d. per ton. This was not very low—he believed it was just about an average. Also, he would say, from the quantity of spent lime Mr. Ewing had been selling, he thought his purification had cost about an average. Might he take it that probably Mr. Ewing's standing charges had something to do with his cheap selling price for gas? He should like to hear something about this. He was sure all the members would feel greatly indebted to Mr. Ewing for having told them that he got from 10,000 to 11,000 cubic feet of gas per mouthpiece. From Mr. Ewing's own figures, he found that he carbonized 10,600 tons of coal, and made 102 million cubic feet of gas, which was about 9600 cubic feet per ton. There was one other question he wanted to ask—why Mr. Ewing, in his setting, had all the secondary-air ports, or nostrils, so small at the front, and getting larger as they went back.

Mr. A. MacPherson (Kirkcaldy) said the first thing that had occurred to him, on looking at the setting, was that it seemed to be a very old and familiar friend of his, designed by him for a small works at Dysart fifteen years ago. He then devised the arrangement for heating the secondary air for the purpose of saving excavation. The foundation was rock; and it would have been very expensive to excavate. He agreed with Mr. Carr that the setting described was not constructed on scientific principles; but he said it was a profitable one for small gas-works. The results which had been obtained with it quite justified its application to any small works where regenerative settings would be far too expensive. They would find that with retorts set on this principle they could easily produce 9000 to 10,000 cubic feet of gas per mouthpiece in 24 hours, at an expenditure of something like 25 per cent. of the entire coke produced. He thought that anyone who wished to introduce such a system in a small place would never rue it. At the same time, he quite agreed with Mr. Wilson that an out-and-out regenerative system was *the* system. He had had experience of direct firing, and also of the semi-regenerative and the full regenerative systems; and certainly he thought the last was the proper setting for works of (say) more than 50 million cubic feet a year. The cost of the settings described seemed to him to be something altogether abnormal. He was afraid there was nothing charged for excavation—preparation of foundations, or floorage, or anything like that, because, from the knowledge he had gained in the construction of the ovens which he had set at Dysart, and which he had since set at other small works, he found that it worked out, without any flooring, but with the preparation of the necessary foundations, at nearly £28. How Mr. Ewing could do the work for so small a sum as £22 was more than he could conceive. He was not calling the figures in question; at the same time it was only wise, in these things, to know exactly what was included and what left out. Otherwise, they might be going on different bases altogether The matter which Mr. Ewing met with—the thick tar—he (Mr. MacPherson) had also encountered; and a most peculiar experience he had with it. In working a regenerative setting, he found, to his horror, one Saturday night, that the pressure would not come down in the retort-house, do what he might. It was down everywhere, but only a little from the hydraulic main. Luckily he had a short distance off a cover which he unscrewed, and he found that in a 12-inch pipe there was a passage of only about 3 inches; the other 9 inches being blocked with thick tar, which he could pull out and spin like a rope. The only way in which they could remove the tar seemed to be by steaming it. However, he thought that, as it had gone so long, it might go a little longer. So he closed it, and kindled up a new setting of retorts, to get a stock of gas. After getting this, he opened the pipe, and found it to be as clean as possible—the heat of the new retorts had been sufficient to again liquefy the pitchy tar. A very effective method of removing such tar, and doing away with choked ascension-pipes, he had found to be the running in of some weak ammoniacal liquor. He was not quite sure as to how it was brought about; but it struck him that by the cold liquor going in and the hot tar coming off, it was so cooled down as to prevent the naphtha evaporating.

Mr. R. F. HISLOP (Paisley) said it was a well-known fact that regenerative settings were more costly than generators; and he was convinced that, notwithstanding the good results which Mr. Ewing had obtained at Hamilton with the latter, as compared with the old system of direct firing, if he had adopted a modern system of regenerative settings these results would have been very much better. There was, for instance, greater durability in the settings, as, after two, three, or more years' working, the first renewal was necessary only for the bed of the bottom retorts, and for the regenerators after twelve or fourteen years; whereas with generator furnaces the whole of the settings had to be renewed every two-and-a-half or three years. With modern regenerative settings, the secondary air had a much longer and more effective contact with the waste gases on their way to the chimney, and consequently they met with the producer gases at a much higher temperature; and these two, rising in vertical columns along the length of the producer arch, commingled inside or above the combustion chamber, above the arch of the producer, with the result that the heat was distributed evenly throughout the setting, instead of above the fuel, as in the case of the generator settings already referred to. Though Mr. Ewing got about 10,000 cubic feet of gas per mouthpiece, 12,000 cubic feet might easily be obtained. Mr. Carr seemed to doubt that Mr. Ewing got 10,000 cubic feet per mouthpiece; but he must bear in mind that Scottish and English coals were very different, and that it might be quite as easy to obtain 12,000 cubic feet of gas per mouthpiece from some Scottish coal as to get (say) 9000 cubic feet from some English coal. With regard to the fuel account, he noted Mr. Ewing set it down at from 15 to 20 per cent.—an amount which, without complete regeneration, must be entirely erroneous. The error was clearly attributable to finding the coke used by difference—that was, estimating the fuel used from the amount sold, the latter containing a considerable quantity of water. Consequently, if he multiplied his fuel account by two, it would be nearer the mark. In the Hislop settings, the waste gases were utilized, not only in heating the secondary air, but in raising steam for the producer, and in keeping the clinker friable; and, by recent improvements, there was no clinkering or using of bars, and no waste of fuel during the heating, and the work was accomplished in about five minutes.

Mr. A. Yuill (Alloa) remarked that there were certain facts specified by Mr. Ewing—the results he had obtained—while in the diagrams he showed the retort-settings. There were several points to which some of them might object. At least, from his own experience of gaseous firing, Mr. Ewing's plan was a mistake—the source of heat being so pent up in the system of flueing. There was a difference between ordinary and gaseous firing, as in the one case they required a much larger draught than in the other. With gaseous firing, they would notice that, when the firing-door was open, the flames belched forth, instead of there being a current of cold air pulled in through the setting when the furnace door was opened for the drawing of the coke. In fact, there was no draught; there was a vacuum—there was no pull at all on the retorts. As to the supply of the secondary air, he thought this was another point which they ought not to copy from Mr. Ewing, because, if they took a section of the supply, as shown, they would find that for the secondary supply they had the one side cold. There might be heat, and a considerable amount of it; but they would not have the same heat as they would if the secondary air were surrounded on the one side by the waste-gas flues, and on the other by the furnace wall itself. Therefore his opinion was that it was a mistake. Then as to the sizes of the air-ports leading in, and the supply of the furnace gases rising from the producer, he had always found it to be beneficial to concentrate the gases rising from the producer, so as to bring them into intimate contact with the secondary air, in order that, as it were, the two would meet and commingle. He had always found that the nearer they brought the secondary air to the supply of the gaseous fuel rising from the producer, the more beneficial it was. With regard to the cost of fuel, he admitted that if they were able to reduce the temperature of the gases as they left the furnace, they were doing what they could to minimize the cost. In this case he could not see how they could reduce the temperature of the gases, as they left the retort-setting, to what they found in a full regenerative setting. Therefore, if they were losing heat they were losing in value, no matter what their results might be. A setting of fives was shown. He had always found that a setting of this number was not advantageous, in this sense—that they could not have one unless they thoroughly protected the top retort, which must be at an expenditure of heat, otherwise the retort would be burnt out. Better results, he thought, were to be obtained by settings of four, six, or eight, because in that form they got a free exit right over the retorts. Mr. Ewing spoke about the pinching of the furnace bars. In his opinion, the setting did not lend itself to allowing them to get the full command which they ought to have. They ought, in his opinion, to have the full command of both the primary and the secondary air, and also of the gases leaving the oven; otherwise they would not have the full command of the setting. He believed the damper had just as much to do with the effective working of the oven as the air supply. His friend beside him [Mr. Hislop] had anticipated him to a certain extent with his new arrangement, and the clinkering of his furnace bars. Last year he put in one setting in which they had done away with side pans, and had been able to have complete control over the supply of primary air, besides making the system of cleaning much easier than formerly. They only required, as it were, to clean the furnace every two days.

Mr. W. B. M'Lusky (Selkirk) said he should like to know the quantity of coal put into the retort, the duration of the charge, and, as nearly as possible, the percentage of ash in the coke; also whether Mr. Ewing found it an advantage to burn the fire down every eight hours, and strip the soles free from clinker—whether he found this an advantage for bridging the fire and drawing the ashes from the bottom every 24 or 36 hours, as was common with the Hislop setting. Something had been said about the setting before them not being scientific; but this was altogether beside the question. He thought Mr. Ewing was to be complimented upon the results he had obtained. It was as an ounce of theory to a ton of practice; and Mr. Ewing had his ton of practice. He should like to know whether those who were questioning this setting were realizing, with their scientific settings, results which would compare with those Mr. Ewing was getting. This might explain the reason for Mr. Carr not believing in a great yield per mouthpiece. They in Scotland liked 12,000 cubic feet per mouthpiece, if they could get it; and it had been got in the Border district for eight years consecutively, by Mr. Walker, at Berwick-on-Tweed. Mr. Walker had produced 150,000 cubic feet of gas from twelve retorts. This had never been reached with an ordinary setting. Of course, it was obtained with a "scientific" setting; and if Mr. Ewing got 10,000 cubic feet with his setting, he did well. This also pointed to the benefit of having a manager who was constructed on scientific principles, because they might have a scientific setting and not a scientific manager. He considered that he had a scientific setting; but possibly he was not a scientific manager, because he could only get 9000 cubic feet of gas per mouthpiece. He should like to ask Mr. Ewing if he found any difficulty with the coke closing when it was more than 4 feet deep, or if he had any difficulty in drawing the air through.

Mr. Ewing, in reply, said Mr. Myers and Mr. Carr mentioned that they thought a great amount of heat would be absorbed by the air underneath the bottom of the retort. He (Mr. Ewing) could not say. He had never tested, nor had he the means of testing, to ascertain it. Mr. Carr considered that a regenerative setting would have been better, even at some extra cost. Of course, he had to act according to circumstances, and, from the results, he found that it was cheaper and more effective to work this setting than those he had in the old benches. Mr. M'Gilchrist had spoken about foundations. In connection with these new settings, strange to say, he originally intended to construct them on the regenerative principle; but unfortunately, on account of the quantity of flint rock underneath, it would have been necessary to incur an outlay of not less than £100 in excavating for the producers. The cost per mouthpiece would thus have been considerably more than the figure shown. He had the advantage of a very cheap quotation for bricks, as well as for retorts; and the foundations were very shallow. The brickwork was built right on the hard rock. There was only one part, at the back, where they had to build up about 4 feet, and consequently they constructed the settings considerably cheaper than they would otherwise have done. But he had no hesitation in saying that under more favourable circumstances he could have built a setting for £20 per mouthpiece. Mr. Vass thought it would have been better to have had the main higher. There also he had to work according to circumstances. The "cloth" was cut, and he had to make the best of it. But in his next settings he had the main about 3 feet above the bench, supported on rolled joists. Mr. Wilson, of Perth, asked for information regarding the quantity of fuel sold, and such like. Of course, this was all given in the table, where he showed the quantity of coke sold and not that used in the boilers; and he found with the present settings that, working with a coal yielding about 11 cwt. of coke per ton, there was perhaps from about 8 to 10 per cent. of ash. If he did not fire the boiler with it (there was a fair quantity used there, and he was sorry to say they did not use breeze), he could sell nearly 9 cwt. of coke per ton of coal carbonized. With regard to carbonizing wages and general statistics, of course he had not heavy standing charges. Even after having spent, during the past six years, between what had been added to capital and ordinary additions to capital, at least £26,000, and taking a lot of money from revenue for unredeemed capital, he supposed that nearly £30,000 had been spent in all. But, with all this, their total loan capital was only £35,000. Mr. MacPherson stated that this setting was an old friend of his. He (Mr. Ewing) did not pretend that the setting was original; and he had never done so. It was only a design to suit circumstances. Mr. MacPherson mentioned that his cost per mouthpiece was £28. Circumstances might have varied. He (Mr. Ewing) had his own retort-setter at Hamilton, and he found that he did the work most effectively, and at cost price, which made a big difference. He constructed the whole of these settings, except the ironwork, with his own men. Mr. Hislop had told them of the advantages of regenerative settings. This was altogether beside the question. He (Mr. Ewing) was treating of generator furnaces; and he had better results than the average obtained with regenerative firing. He thought that in gasworks where there was too much complication good results were never realized. The simpler the settings, the better the results. Mr. Yuill said he worked his producers at a vacuum. He (Mr. Ewing) had done so with this setting; and he had found by experiment during 24 hours, and also during another test of three days, a fuel account of 14 per cent. So that he did not see where the advantage came in of the elaboration which there was in regenerative furnaces, when he could get it, with greater simplicity, at about half the cost. Mr. Yuill preferred retort-settings of fours, sixes, or eights. He (Mr. Ewing) had found, in his experience, that a setting of fives was a weak one, though he had had such a setting working for three years without requiring anything more than a little repair to the front. Mr. M'Lusky wanted to know the quantity of coal carbonized per retort. He ran charges varying from 2¾ to 3½ cwt. for four hours. By running them for this time he found there was less wear and tear on the retorts. His settings, with the exception of one or two mishaps—the burning away of the arches and the like—he found to run from two to three years; and he had one which had gone on for three years constantly without requiring renewal.

The PRESIDENT remarked that they had learnt a great deal from the paper, but considerably more from the discussion. He was something like his friend Mr. Ewing. Mr. MacPherson said the setting before them was an old friend. Well, he was one of the old-fashioned gas managers, and he thought it was a great pity that they should have scientific, practical men among them that day who could not work such settings as this. Many years ago he was instructed to make inquiries as to regenerative settings. Settings of threes and fours were the most popular at that time. He made all inquiries as to cost, results, and so forth, and he found that, with his old, unchanged settings, he had better results, at about a third of the cost. He thought it was a great pity that practical men could not get better results without going in for expensive works. His settings at Coatbridge were pretty much the same as those now before them, and he obtained first-class results. Both Mr. Ewing and himself had the disadvantage of having a small number of retorts in an oven. If they had a greater number, perhaps their cost would be down 10 or 11 per cent. Another manager might fancy a £46 setting; but so long as he (the President) could get as good results with a cheap setting, he was not going to introduce a dear one. He thought they would all be the better for the reading of Mr. Ewing's paper.

Mr. A. Wilson (Perth) read a paper giving his

EXPERIENCES WITH PREPAYMENT METERS.

The introduction of these instruments for the control of the delivery of gas to the consumer marked a new epoch in the history of lighting by gas. By their means it became possible to include as consumers a class "whose room was preferable to their company," before their introduction, but who may now be looked upon as the best paying class of consumers.

Fully two years ago, these meters were introduced in Perth; and, as the popular saying goes, they immediately "caught on," so that at the present time over 1100 are in use. Of these, fully 800 are supplying gas to new consumers; the remainder to bad payers, and those who found a quarterly account too much of a sudden drain.

A certain amount of caution had to be exercised in fixing these meters, as applications for them were at first received from old consumers, despite the fact that the bulk of them were well served, and could well afford to run a quarterly account without feeling any inconvenience. However, in course of time, these unnecessary applications ceased to come in; and now applications are only received from new consumers, or from those who have compulsorily or otherwise ceased to be consumers by the ordinary system. A considerable number of these meters are fixed in conjunction with a griller, boiling-ring, or cooking-stove, which latter are fixed free of charge.

Prepayment meters fixed in this manner are greatly in favour with lodging-house keepers. Last year the average number of these meters in use in Perth was 1020; the average consumption being 6000 cubic feet per meter. The gas-rate in Perth is 3s. 2d. per 1000 cubic feet; and 20 cubic feet are supplied for 1d., or at the rate of 4s. 2d. The extra revenue from this source was therefore 6s. per meter, or a total of £306. This sum we find covers the interest at 3 per cent. on the extra money expended on these meters; pays the working expenses of the system; and leaves a handsome balance.

The bulk of the meters are two-light drys, costing £1 18s. 6d. each, or 18s. 11d. more than the ordinary two-light meter. This sum, at 3 per cent. on 1020 meters, means £28 18s. 10d. yearly. A collector and a boy assistant are continually employed collecting the coin, at the respective wages of 29s. and 5s. per week, or an annual sum of £88 8s. After deducting these two sums, we still have the respectable total of £188 13s. 2d. as the net profit by the use of this system over the ordinary one. You will observe I charge all the collectors' wages to this system, which I think I am entitled to do, as extra assistance was required shortly after its introduction.

The working of these meters entails more labour than the ordinary meters, as the coin collected weighs considerably more than a survey-book; and the collector may have to call six times before finding the consumer at home. The bulk of these consumers are millhands, and those whose work necessitates their being from home all day. Thus the collector's work is considerably increased from this cause. We find it also necessary to provide the collector with a light two-wheeled barrow to transport the coin, and a boy to be always in attendance on it.

Several short paragraphs have appeared lately in the West of Scotland papers giving the weight of copper taken by certain gas undertakings from these meters during one month. The figures I forget at present; but Perth with its modest 1020 prepayment meters collected last January 10 cwt. 2 qr. 18 lbs. of coppers from them. Such was the scarcity of coppers in the city during the month that it created serious inconvenience to several of the large shopkeepers, who besieged the Gas Offices clamouring for change. The matter was brought under the notice of my Committee, who could not, however, see their way to remedy it. Over the year, we collected 306,000 pennies, weighing 2 tons 14 cwt. 1 qr. 19 lbs. Such is Perth's record.

Regarding the meters in use, they are all of Scotch make, and have given us every satisfaction. Of course, at times, they have got out of order; but we found that this was oftener attributable to the fault of the consumer in not paying attention to the printed instructions than to any defect in the meters themselves. It is surprising how some people will disregard or misconstrue the instructions attached to each meter, and try to manipulate the meter in any and every way but the right one. Then, again, bent pennies were a source of great annoyance to us; but I am glad to say this difficulty has been overcome by the makers forming the slot of such a size that a badly bent penny will not enter —at least with any reasonable pressure—and making the case or barrel of the meter large enough, so that the penny does not get jammed in it if forced through the slot.

Some of our consumers look upon the meter as a receptacle for all the pieces of tin or other material that may find their way into their possession; and they show an amount of surprise and indignation, when called to account for it, which is worthier a better cause. Others, again, seem to think that the abstraction of the coin from the meter is their just and due right as part owners of the gas undertaking. An example made of one or two of the latter in the Sheriff Court has had a lasting effect on the morals of their would-be emulators. There are others who use the meter as a savings-bank placed handy for their accommodation, by inserting florins instead of pennies. On the approach of the rent-day, many are the applications at the Gas Office for the collector to let them have the balance not due to us, to enable them to meet the rent.

These are a few of the experiences gained during two years' use of the prepayment system; and they are such as to justify our adoption of it.

A scheme to which I look forward with interest, is that of supplying and fixing free of charge, in conjunction with these meters, grillers and boiling-rings. The extra revenue which will undoubtedly accrue from the introduction of such a scheme will, I am sure, go far towards meeting the additional expenditure involved—much less covering the interest.

Discussion.

Mr. R. S. Carlow (Arbroath) said he thought the members were much indebted to Mr. Andrew Wilson for giving them his experience with prepayment meters. At Arbroath, he might say, they did not begin the use of these meters till far on in the year. Their year ended on the 31st of May; and it was after the

New Year that they began to use prepayment meters. Since they had adopted them, however, they had put in between 300 and 400 of them. They had placed to capital account upwards of £700 as the price of the meters. On the other hand—he made a note of it on the previous day—they had gained from the prepayment meter system, during that period, nearly £180. This was from the month of January; and during that time, too, they were only putting in the meters occasionally. He considered they were making a very great profit from them. He was quite at one with Mr. Wilson that it was the correct thing to do to provide certain consumers with prepayment meters. He had put a great many of them in the houses of consumers who used to burn oil; and, on the other hand, he had substituted them for other meters in the cases of consumers who caused a great deal of trouble—people from whom they did not know when they would get their money. If they carried on as at present, he had no doubt they would make a very good profit indeed for the Corporation. He thought the prepayment meter system should be considered by every gas manager present, because there was no risk whatever with it. There was no deposit needed—their money was there; and they should encourage, as far as possible, gas consumption in every way. As Mr. Wilson had said, they connected gas-stoves or boiling-rings, or any other form of gas apparatus, with a prepayment meter; and they were sure of their money. In such towns as Arbroath, where there were a great many mills, they would know that boiling-rings, costing about half-a-crown, were greatly used in the mornings and at meal hours, and gas was consumed by them to a considerable extent.

Mr. T. W. **Ward** (Stevenston) said that, from his short experience, and with gas at 5s. 10d. per 1000 cubic feet, the members would not expect that he had done very much with prepayment meters; but he had heard a great many complaints about the length of time a pennyworth of gas lasted. It was only from 2½ to 3 hours. In such cases he had found that the consumers were using No. 7 burners. He took off these burners and put in smaller ones; and he had had no complaints since then. He thought gas managers should, in putting in a prepayment meter, look to the size of the burners to be used.

Mr. J. **Ballantyne** (Rothesay) said he had a great many prepayment meters in use in Rothesay. He was about the first to introduce them; and he had had some strange experiences with them, especially where people went to Rothesay for the benefit of their health. They might be sitting up reading their favourite novel, and be just coming to an exciting point, when out would go the gas. This annoyed some; while others thought there were burglars in the house. However, they got over these things; and, so far as he knew, prepayment meters were giving great satisfaction. He thought they had about 600 of them. They very often had to go round to these meters between collecting times. Their regular collections were every four months; and frequently they had to go at two months, and take away the money. They often found as much as from 25s. to 30s. in the box. He rather thought that, in many cases, if they were to present a bill for 7s. 6d. to these people, they would say they were being robbed; but when they put in from 25s. to 30s. themselves, they never said a word. The Corporation had reduced the price of gas since the introduction of these meters; but, instead of changing the setting of the meters, they returned a certain amount to the consumers. When their man called, the consumers, instead of grumbling, were glad to see him, because they knew they would get something back. There was a great future for prepayment meters. They were only beginning to get into some towns. If they were carefully worked—not given to all consumers, but to consumers of other lights, and the like—they would be very profitable. He found he was opening a good many new accounts; and their income was increasing rapidly. He considered that towns which were not introducing them were standing in their own light. He did not see why any gas manager should not be able to very largely increase, if not actually to double, his consumption, by means of prepayment meters. They certainly cost a little more than others; but they did not give so much trouble now as at first, so that there was nothing to fear. Therefore, in this regard, and taken all through, he thought they had every reason to be thankful that they had prepayment meters at their command, because they gave them the opportunity of having as gas consumers people who would never have been in their ledgers.

The PRESIDENT said he had had a little experience with prepayment meters, as he had about 1400 of them in use at Coatbridge. He thought he was about the first to adopt these meters in Scotland. He was a little reluctant in doing so at first, as he considered they would not have a class of consumers for them. But he had found they had. Now they had somewhere about 25 per cent. of their meters on the prepayment system. Last year they sold about 7½ million cubic feet of gas through these meters. They had given satisfaction to everyone almost. Prepayment meters were largely used in his place as banks. They had had as many as twelve florins in one. It was no uncommon experience for people to come and ask them to take the money out, as the box was too full. They tried Mr. Ballantyne's method of handing money back; but he was not sure that it was altogether a satisfactory one. It certainly put the collector in a rather curious position, because the money must correspond with the meter index; and they considered that the better way was to set the indices again. They did this. No doubt it gave a little trouble; but, after all, two men did about 100 meters a day. They now had them all set to give 28 cubic feet of gas for 1d. Their ordinary price was 2s. 6d. per 1000 cubic feet. They had found prepayment meters to be a great benefit. Fourteen or fifteen of the largest iron-works in the district had introduced electricity, and so they had lost them entirely as consumers of gas. But the extra revenue which had been brought in by prepayment meters had made up for this.

Mr. A. Wilson, in reply, said this was his first contribution to their proceedings, and it was certainly very gratifying to think that the members had listened with such patience to one who was a tyro in the matter of reading papers. He found, like Mr. Ward, that people were going to ironmongers and getting large burners; and at first he had a little trouble in this way. Eventually, however, he got consumers to know that they should not use such burners. His Committee, when they introduced prepayment meters, did not see the force of charging poor consumers a higher price for gas than rich ones; and the consequence was that, the consumers by prepayment meters getting their gas at the same price as the others, while the Committee were paying something like 18s. 11d. for a two-light dry meter, they lost upon them that year. The profit derived from these meters did not pay the wages of the men who were put on to look after them. They had gone to the other extreme now, and were charging the prepayment consumers 1s. per 1000 cubic feet more than consumers by ordinary meters; and they would have to come down from that.

Mr. Gilbert Little, of the New Conveyor Company, Smethwick, read the following paper:—

THE AUTOMATIC MANIPULATION OF COKE.

Many a true word is spoken in jest. This truism was uppermost in my mind recently, after a discussion with Mr. Hack as to the best designs of conveyors and elevators to automatically manipulate coke. I had jocularly remarked, "I think, Mr. Hack, you and I have had the most varied experience, and made the greatest number of mistakes, in connection with automatic appliances for coke; and therefore we now ought to possess the 'dear bought wit' which should enable us to steer clear, in future, of the faults of the past." Mr. Hack made it clear, however, that he favours the view which Macaulay gives expression to in his essay on "The Effects of Progress"—that it is unreasonable and ungrateful in us to be constantly discontented with conditions which are constantly improving—as he replied, "I have no objection to your commencing your paper at the North British meeting by that jocular remark, if you will limit it, as far as I am concerned, to the words 'largest experiences;' for while you may feel justified in adding the further remark, 'made the most mistakes,' I cannot debit myself with it. I can only admit having made substantial and important improvements over my first installations of such apparatus." Well, I have formed a less contented estimate of the past in connection with coke-conveying appliances than Mr. Hack; and the words of a much older historian than Macaulay sum up not inaptly the twelve years' experience of the New Conveyor Company: "Wisdom has come through experience, and understanding through length of days." I claim, however, that we have gone on constantly improving, because there was room for constant discontent down till even a recent date.

I shall not take up any of your time by describing faulty and discarded designs, but will confine this short paper to a few descriptive comments on the plans before you, as they illustrate some of the latest methods of conveying, elevating, screening, sorting, and stacking coke from moderate-sized retort-houses; and the drawings could be modified to suit almost any condition of circumstances to accomplish the automatic manipulation of the coke in a large majority of gas-works.

Before asking you to follow me through diagrams 1 to 5 (pp. 214-18), let me, in a sentence or two, refer to other well-known methods. The first mention is due to the arrangement at the gas-works of this flourishing city of Glasgow. You are familiar with Mr. Foulis's system of dwarf locomotives and trains of tipping trucks—a system very suitable for exceptionally large works; and when arranged in conjunction with elevators to lift the coke, and conveyors to trim and stack it all over the storage yards, or with hoppers, a vast saving in the wear of workmen and wages must be effected.

The birth of the New Conveyor Company to carry on the business of conveyor and elevator specialists occurred just prior to the opening of Glasgow's great Exhibition in 1888. We there exhibited different forms of conveyors for the first time. Since that date, I have been indebted to Mr. Foulis for useful hints; and it is only right I should mention here that the satisfactory designs which we have put in so as to replace the "Made in Germany" appliances of coal-washing plants, were constructed similar to the elevators which we supplied to the drawings of Mr. Foulis for the Glasgow Corporation Gas-Works.

Let us now cross the Border so as to refer to one or two coke-handling plants. In many English counties, there are a large number of good systems of automatic appliances manipulating the coke at ranges of coke-ovens. The time at my disposal will not admit of placing particulars of these before you; but any of you who may happen to be in the county of Durham can see the conveyors and elevators we made to the order of Mr. Bower, of West Hartlepool, to carry the coke from a bench of inclined retorts, and deliver it to the waggons on a railway siding. From West Hartlepool, it will repay you to go on to Nottingham, to inspect the elaborate coke-handling plant designed by Mr. W. R. Chester. In the gas-works at Nottingham the coke is taken hot from the retorts, quenched in transit, carried into overhead hoppers, and sized ready for loading into waggon or trucks. The arrangement also admits of the coke being automatically transferred from the hoppers, through a coke-breaker and screen, to be washed and cleansed for special trades. The machinery can deal with 300 tons of coke per day; and it sorts into five distinct sizes for the special requirements of the markets supplied by Nottingham. Altogether the automatic manipulation of coke at Nottingham reflects the highest credit on Mr. Chester and the contractors for the work. From Nottingham, it is not a "far cry" to Birmingham; so I transmit you there, where you may decide to spend a few hours at the New Conveyor Company's works inspecting conveyors and elevators in all stages of manufacture, and for every purpose. Then we go on to the Windsor Street, Saltley, or Swan Village gas-works of the Birmingham Corporation, to satisfy ourselves that progress and "push" did not cease at Birmingham when Mr. Chamberlain migrated from Municipal distinction to gain Imperial renown.

There are other coke-conveying plants over the Border too numerous to mention; so I direct your attention to the five illustrations shown. I confine myself to these five illustrations as they display sufficient variety to make it clear that one or other of them could be modified to suit almost any gas-works. A further reason for limiting myself to these drawings is the fact that I have had special opportunities of discussing, for several months, the details of these arrangements with the engineers and managers of the several gas-works to which they refer—viz., Mr. Foster, at Nelson, Mr. Fenner, at Chesterton, Mr. Carr, at Widnes, and Mr. Morris, at Jersey.

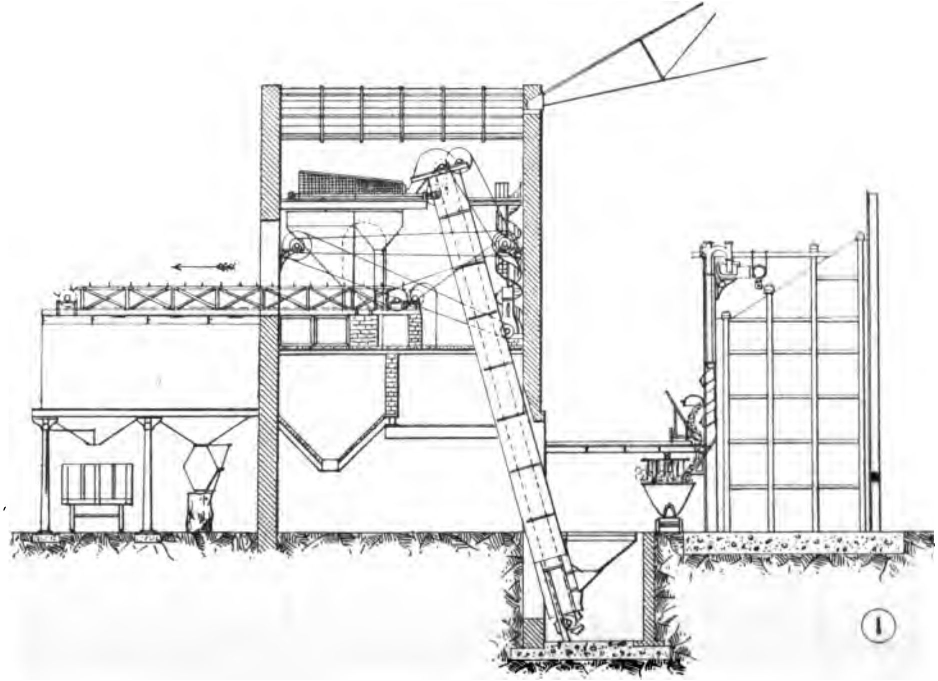
Fig. 1 shows Mr. Foster's arrangement at the Brierfield works of the Nelson Corporation, Lancashire. We recently finished the contract there for a complete gas-works, as we were the contractors for almost everything, from the weigh-bridge to the Manager's key. The carbonizing plant is entirely automatic, from the time the coal is tipped from the waggons until the coke is distributed, as you see (from fig. 1) into the various storage hoppers. The coke slides from the inclined retorts into the tipping-truck; the attendant then turns on the water, which sprays over the hot coke until it is quenched; and the truck is next moved, and the contents tipped, to be taken by the elevator to the circular screen. This screen is made to adjust so that the coke can be sized, as desired. As a rule, three sizes are made and distributed into the three ranges of hoppers. The carts or sacks are filled from the hoppers by pulling the levers to open the outlet doors.

Fig. 2 shows the arrangement for the retort-house at Chesterton. You will observe that conveyors are fixed in front of the benches; and the coke is carried from each bench of retorts by the two conveyors as shown. These, in turn, shoot the coke into the conveyor fixed at right angles. which carries it to the railway waggons. The shoot to conduct the coke from this conveyor to the railway waggons is made with screen bars, which separate the breeze, and discharge it into the shoot as shown.

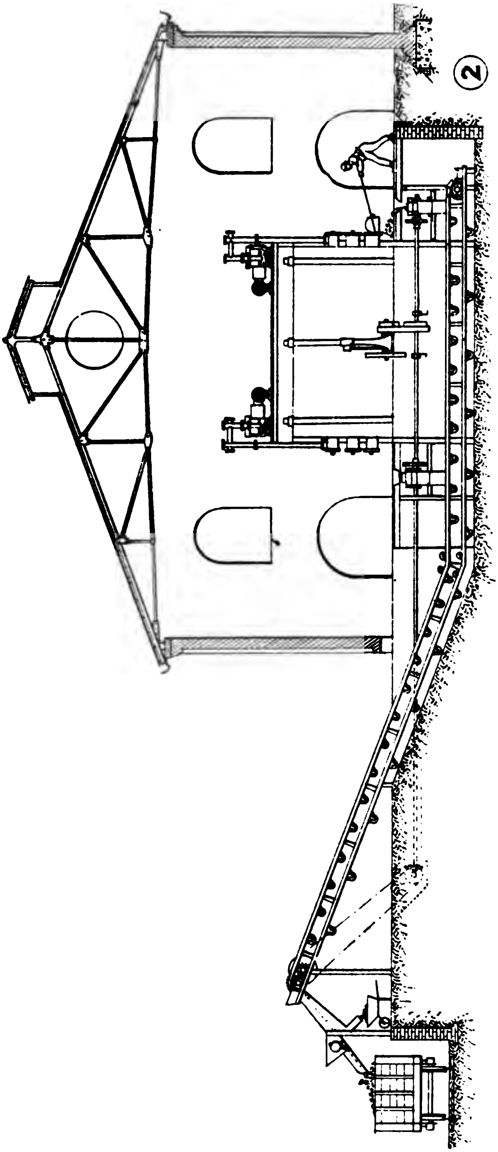
Fig. 3 shows an arrangement to meet the special requirements of the coke-trade at Widnes. It is, however, suitable for a large number of gas-works; and Mr. Isaac Carr, the Engineer and Manager at Widnes, in giving his consent for this drawing to be made and put before you, wrote me as follows: "I do not know that it contains any special merit over that of any other coke plant. It is simply arranged to suit the local conditions; and that is all that can be said about it." Well, gentlemen, I could say a good deal more about its merits; but I leave the drawing to speak for itself.

Fig. 4 is an illustration of an arrangement for one of The Gaslight and Coke Company's works in East London. The retort-house is over 300 feet long, with two double benches, containing some 200 retorts. You will observe four conveyors run along the front of the four rows of mouthpieces, and convey the

Figs. 11 to 15.—Installations of the New Conveyor Company's Plant.



Conveyor at the Nelson Corporation Gas-Works.



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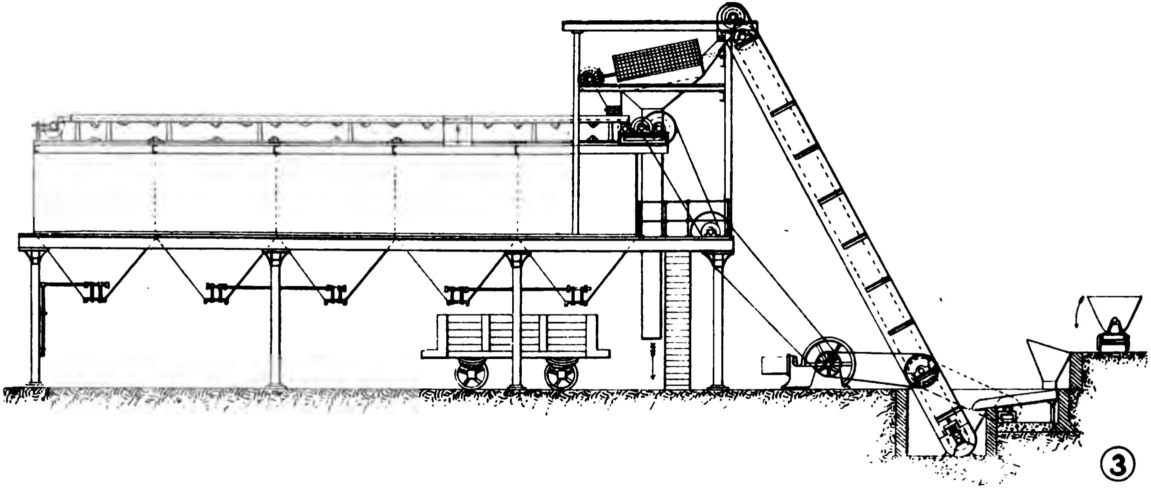
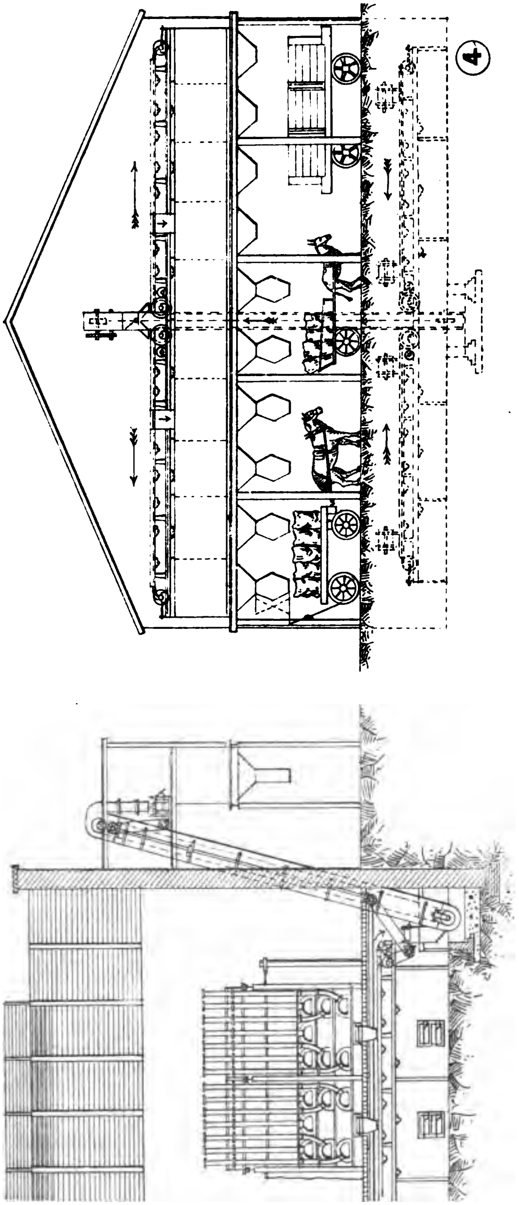
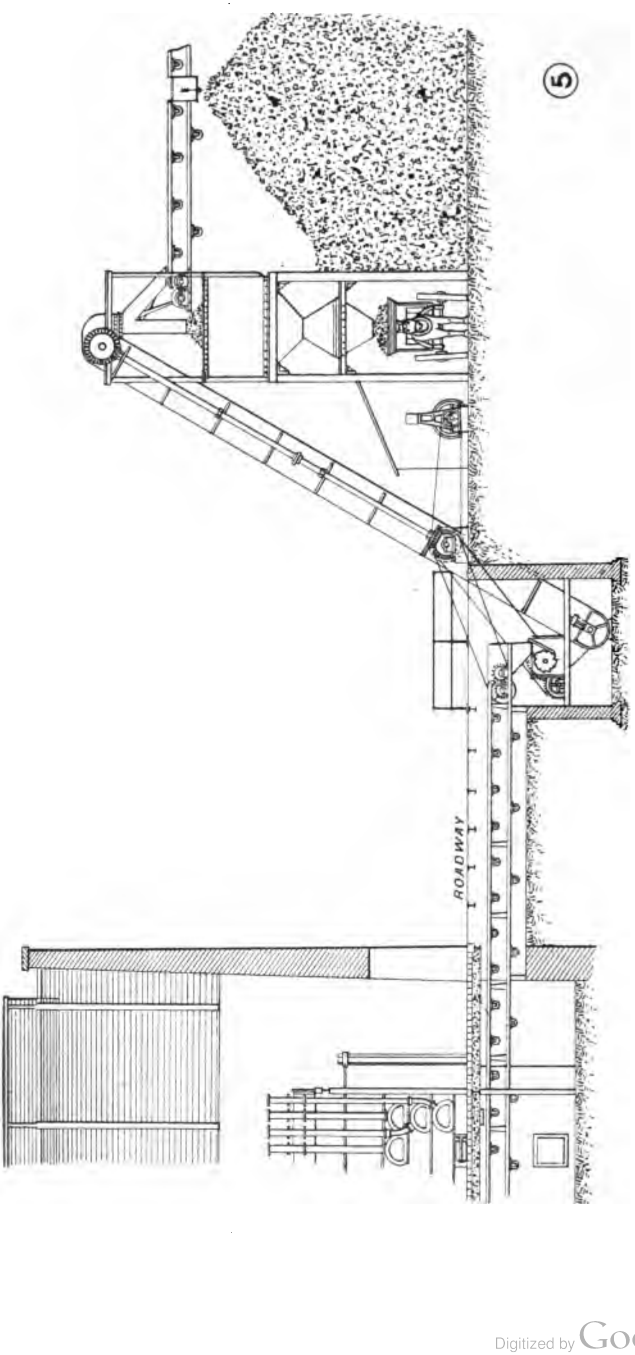
RETORT-HOUSE CONVEYOR AT CHESTERTON.



Coke Conveyor at the Widnes Corporation Gas-Works.



Conveyor at The Gaslight and Coke Company's Works.



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CONVEYOR FOR THE NEW RETORT-HOUSE AT JERSEY.

coke to the conveyors at the end of the retort-house, which in turn deliver it to the elevator. The elevator drops the coke on to the conveyor fixed above; and this trims it all over the storage hoppers. You will notice that measuring chambers are fixed on the bottom of the storage hoppers to fill the sacks.

Fig. 5 shows the arrangement for the new retort-house at Jersey. This retort-house (recently completed) is one of the best I have ever seen. I wrote Mr. Morris, the Engineer and Manager at Jersey, asking his permission to make and exhibit this drawing to you; and he replied as follows: "I have no objection to your showing your drawing of my retort-house; but I do not think I have any claim to have it called 'my plan.' The idea arose from our joint conversations." I had accompanied Mr. Morris to works where our coke-plants are in operation; and I had also visited Jersey to see the new retort-house, and discuss the best arrangement to meet the special conditions. The result was the method shown on fig. 5. You will notice the coke is conveyed along the front of the benches under the cartway; and, passing through the coke-breaker, it is elevated to the hopper above. The delivery shoot of the elevator is made with a deflecting valve, by means of which part of the coke is delivered to the hopper, and part to the conveyor, to be delivered on the coke stack; or all the coke can be delivered to the hopper or the coke stack. Under the large storage hopper a smaller hopper is arranged to deliver a certain weight of coke into the carts. The cart is brought under the hopper; the carter pulls the lever; and away he goes within a minute with his load.

I have given to you very meagre descriptions of the illustrations; but it will afford me pleasure to arrange for any gas manager to inspect some of our plants in Scotland. Some of our best installations of self-acting machinery are working in the town and district of the President, Mr. Wilson. In the iron and steel works at Coatbridge, automatic arrangements of conveyors and elevators distributing the coal to, and taking the clinkers and ashes from, batteries of furnaces and ranges of gas producers are at work.

Discussion.

The President said they had listened to a valuable paper. The drawings shown were splendid, and were easily understood. If the members had any questions to put to Mr. Little, he had no doubt that he would be very pleased to answer them. He supposed their feelings would be that their works were too small to adopt such appliances as Mr. Little had described; but there were gentlemen present who had large works.

Mr. A. Wilson (Dawsholm) said he had had great pleasure in hearing this paper on conveyors. Of course, the drawings that Mr. Little had shown would, he had no doubt, be suitable for their different works. They always had the idea that conveyors for manipulating coke were not very practicable, as there was such a great deal of wear and tear on them; so that, in the Glasgow works, Mr. Foulis had not adopted such conveyors, but had employed the narrow-gauge railway, with tipping-waggons, which they had found very suitable, and also very economical. Of course, in a great many works, small railways could not be adopted; but in the Glasgow works they answered very well indeed. They had a different arrangement for screening the coke. They did not use an elevator, but a crane with a drop bucket to raise the coke; and they screened it in this way. He had had some experience of a conveyor for the carriage of lime-shell; and the wear and tear was very serious indeed. It was not very encouraging to them to adopt it; and their present arrangement compared favourably with any of those he had seen for dealing with coke. The coke, when screened, fell down different shoots, and was directed into different places, as in the arrangement before them. Of course, each works had to adopt the best means of handling the coke to suit the place.

Mr. A. Waddell (Broughty Ferry) said he should like to ask Mr. Little the smallest size of works in which he thought it would be advantageous to adopt the apparatus shown.

Mr. Little said that in the first drawing there were only six beds in it; in the second, eight beds; and the last one had only eight beds. There were eight retorts in a bed in the last two, and six in the other.

Mr. Waddell asked what would be the cost of the plant mentioned as applicable to the smallest works.

Mr. Little replied that he knew of no place where they had so many operations to perform as at Nottingham, where the coke was separated into six sizes. This was very expensive—some where about £1600.

Mr. A. MacPherson (Kirkcaldy) said he had not the slightest doubt that, where the works were of sufficient size, there must be a considerable saving in adopting these machines. He did not know whether the apparatus would be quite suitable for Scottish gas-works; but he had no doubt they could be applied there just as well as in those in England, where they worked chiefly with coal which produced a good coke. In Scotland, on the other hand, they very often had a considerable quantity of useless coke, which came from shale and other coals of that class. But where the coke was all of one quality, he could very well understand that this plant would be of very great service. The only difficulty he could see would be where from one charge they might have good coke, and from another bad. There might be difficulty in the separation of them. Possibly Mr. Little could so arrange it that, instead of the bad coke going into the hopper it could be passed on to another, where it could be at once conveyed away without re-lifting of any description. He could quite see that the apparatus would very much facilitate the work of a retort-house; and certainly, if, as Mr. Little said, it paid to adapt it to a bench of six or eight beds of retorts, there were a large number of works in Scotland, he was quite sure, where they could afford to introduce the plant. The subject was one which he had never thought of; but when one saw it demonstrated, it made one think whether it would not show a considerable saving.

The PRESIDENT said he was sure they were all very much indebted to Mr. Little for bringing forward his paper. Like Mr. MacPherson, he had not considered the subject, but, now that the drawings had been put before him, and the apparatus shown thereon described, he possibly might look into the matter. He had seen the apparatus at work in his town, and it was certainly very simple and effective; and if there was anything in it, there was no reason why they should not have it. He had a very go-ahead body of Directors at Coatbridge; and if he could show to them that it would save 5 per cent., and they knew they could borrow money at 2½ per cent., they would say: "Go on with it to-morrow."

Mr. LITTLE, in reply, thanked the members for their reception of his paper. He thought that the cheaper the coke was, the more reason there was for having machinery, because good coke would always pay for handling.

Mr. W. CARMICHAEL PEEBLES (Edinburgh) read a paper entitled—

SOME NOTES ON THE MODERN COMMERCIAL GAS-ENGINE.

When asked a few weeks ago to read a paper on gas-engines before the North British Association of Gas Managers, I must say I felt great misgivings as to the treatment of such a subject, owing to the short time at my disposal. The numerous papers and lectures which have from time to time been given to the public, through the medium of many learned societies and the press, also make it somewhat difficult to bring forward fresh points of interest. I must crave your indulgence, therefore, while I endeavour to engage your attention for a little on this subject, which is growing in importance day by day; for there can be no doubt that the gas-engine is becoming more and more recognized as a standard type of machine for the economical production of motive power. The simplicity of the modern gas-engine brings its management within the scope of individuals of ordinary intelligence, who may not even be connected with engineering matters; and the prejudice which at one time existed against it, and still may exist in the minds of a few, is being gradually overcome. That this is so is well shown by the enormous numbers now manufactured and in use all over the country.

In treating my subject, "Some Notes on the Modern Commercial Gas-Engine," I shall, in the first place, recall to your minds very briefly the history of the particular engine which, almost to the exclusion of all other types, holds the supreme position on the market at the present time. I allude to the "Otto cycle" gas-engine. One cannot but feel astonished, in looking over the patent records for the last thirty years, to see the extraordinary number of inventions—some of them, seemingly, of the greatest possible merit—which have failed when put to the hard test of practical work. The gas-engine patent records are no exception in this respect. Hundreds of patents, representing the work of a multitude of minds, have been laid on the shelf as useless, chiefly owing to the discovery of the "Otto cycle," which made the gas-engine a real success, and raised it to the proud position of being a competitor with the steam-engine.

The cycle of operations in the Otto engine was first suggested by a French scientist, Beau de Rochas, about the year 1862. At the same time he also pointed out the advantages of compressing the charge before firing. Compression, it is true, had been tried by Barnett in 1838; but the real advantage of it was not properly understood until Beau de Rochas came forward and stated, after much study and investigation, that the conditions necessary for economy in the gas-engine were: (1) The largest cylinder volume with the smallest cooling surface. (2) High piston speed, giving rapid expansion. (3) The greatest possible expansion. (4) The highest possible initial pressure before expansion.

The fact that these are the conditions aimed at by manufacturers to-day shows how well Beau de Rochas understood the true theory. He was, however, too soon with his discovery; and it lay latent for nearly 15 years, during which time little appears to have been done with his suggestions. This was, no doubt, owing to inventors trying to follow on the lines of the steam-engine; their endeavours being to produce a gas-engine either single or double acting.

The gas-engines then made were of several types—nearly all being atmospheric or non-compression, and giving an explosion at each outstroke of the piston. The most popular was the Otto and Langen, manufactured at Deutz, in Germany. Some of you may have seen these curious engines, with the rack connecting-rod gearing into a clutch pinion on the crank-shaft. On the upward movement of the piston, the pinion driven by the connecting-rod ran round free; but on the down-stroke the clutch engaged with the crank-shaft, giving it rotary motion. The explosion merely lifted the piston, which was of great weight, to the top of the cylinder, the latter being vertical. Advantage was then taken of the vacuum produced by the cooling gases, when the pressure of the atmosphere, assisted by the heavy piston, gave the power to drive the engine. The noise and vibration produced were very much against the engine; and its popularity was, no doubt, due to the low gas consumption—about 44 cubic feet per brake-horse-power per hour—compared with nearly double that quantity used by other engines then made.

While manufacturing the Otto and Langen engines, which were finally brought to a high pitch of perfection, Herr Otto seems to have continued experimenting; and experiments carefully conducted by an earnest worker are certain to bear fruit. He, no doubt, fully realized that the gas-engine had a great future before it, and was aware of the necessity of providing a system which would be more reliable, and less noisy, than that used in the Otto and Langen engine. The result of his work was the adoption of the cycle suggested by Beau de Rochas years before, and the production of the excellent Otto silent gas-engine. This engine was exhibited at the Paris Exhibition of 1878, and created quite a revolution in the gas-engine industry. Messrs. Crossley Bros., of Manchester, secured the patent rights for this country; and through the excellence of their manufactures they soon established the business on a firm footing. Of course, they had practically a monopoly of the whole trade for ten years. Although several other engines appeared during that time, yet, owing to their complicated construction, none of them enjoyed the popularity gained by the Otto engine.

The stimulating effect of the competition set up among makers and inventors was by no means all lost, as many results were obtained by their endeavours, and numerous details were perfected and patented, which put them in a better position for realizing the benefits of the Otto patents when these expired in 1890. At the expiration of these valuable patents, nearly all manufacturers gave up making their own special types of engines, and adopted the Otto cycle—recognizing in it the only really practical cycle for a simple and efficient gas-engine.

The great changes which have taken place in the engine since first brought out by Otto are: (1) The method of igniting the charge. (2) The adoption of lift-valves in place of the slide-valve. (3) The increase of compression.

These all appear exceedingly simple matters; and one is apt to wonder how so many years of constant endeavour and continuous work were required to bring about these changes. Those, however, who have done original experimental work, and have a knowledge of the intricacies of the gas-engine theory, will allow that the great advance made within the course of 25 years or so has been well, and even quickly, brought about.

The slide-valve was for years a great hindrance to the development of the engine. High compression was impossible, as the slide had to be pressed so firmly to its seat in order to keep it tight, that great difficulty was experienced in lubricating it properly to prevent tearing. Both manufacturers and users suffered through this evil; and the slide proved a continual source of worry. Its effect upon the economy of the engine was also very considerable, not only through the necessarily cramped port area, and consequent small volume of gas and air admitted at each stroke, but also owing to the heavy drag put upon the engine, as the power absorbed in driving the slide was very considerable.

Compression has been continually on the increase ever since the adoption of the lift-valve. In the early days compression ranged between 25 and 30 lbs. per square inch, while now the ranges found are generally between 70 and 90 lbs. per square inch, depending on the size of the engine. Of course, while stratification of the charge was so much believed in, and considered of such importance in reducing the shock of explosion, the idea of higher compression would, in all probability, have been ridiculed, as high compression and stratification are quite opposed to each other. However, this erroneous theory, and many others held by early inventors, were finally disposed of, and with the introduction of lift-valves for the admission of the charge, the compression has been increased year by year as other improvements would allow, resulting in greater economy of gas consumed in the engine.

How far compression may ultimately be carried, it is impossible to say. It would seem, however, hardly practicable to increase it further under the present cycle, for the simple reason that all parts of the engine which receive the strain must be designed strong enough to resist the entire shock of the initial pressure of one explosion only. If we could have a compound engine, or even a double-acting engine, receiving an impulse at every outstroke and instroke of the piston, almost any pressure could be dealt with, without the engine becoming unduly large for the power given out. At present the initial pressure rises as high sometimes as 320 lbs. per square inch; and although this is only for an instant, and occurs but once in every four strokes, yet the engine must be strong enough to resist that pressure, and excessively heavy fly-wheels are required to keep the speed constant during the idle strokes.

This increase of compression has more to do with the economy of the modern gas-engine than possibly any other change—firstly, by the reduction in the size of the compression space wherein the burned products may lodge at the end of the exhaust stroke; and, secondly, by the more intimate and closer mixing of the particles of gas and air, thereby insuring a more complete and instantaneous explosion. The highest temperature of the explosion being reached more rapidly owing to the higher compression, it is not so greatly affected by the cooling action of the cylinder, as the cylinder surface is not much exposed until the piston has moved a little forward; and by that time the bulk of the power contained in the gas is given to the engine.

Mr. Dugald Clerk, in his excellent work on "The Gas and Oil Engine," gives some tests showing the result of increased compression on a Stockport gas-engine, as manufactured by Messrs. J. E. H. Andrew and Co., Limited, of Reddish. The engine tested was altered by fitting on compression chambers of different capacities. It gave, with 60 lbs. compression, 20·8 brake-horse-power on a gas consumption of 22·3 cubic feet per brake-horse-power per hour; while with 90 lbs. compression the brake-horse-power rose to 24·4, and the gas consumption decreased to 20·75 cubic feet per brake-horse-power per hour. This is an increase of 17 per cent. in the power, and a decrease of 8 per cent. in gas consumption.

From the earliest date down to the present day the ignition of the charge has been a continual source of trouble; and there are many engines, even of recent manufacture, which give annoyance in this respect. The difficulties connected with the ignition of the charge have not easily been overcome. Being such an important factor in the economical working of an engine, there is little wonder that so much care has been bestowed upon the igniting arrangements. Of course, the ignition is the life of the engine—the vital spark, so to speak, which transforms the charge of gas and air into the power which is given out through crank and fly-wheel. When watching any good modern engine at work, fitted with tube ignition and timing valves, one is apt to imagine the whole thing very simple. But the fact is the igniting arrangements have had to pass through many changes before being brought to their present state of perfection.

So long as the engines were of the non-compression type, the charge was easily fired by an external flame, which was sucked into the explosive mixture when the slightest vacuum was formed in the cylinder. We all know—some of us from actual experience, through the wrecking of houses, holders, governors, and meters—how easily a mixture of gas and air at atmospheric pressure is exploded; in fact, special precautions have to be taken to prevent accidents on this account. But compression at once changes these conditions. A flame applied to the orifice of a vessel containing an explosive mixture under pressure has no tendency to run in, but burns fiercely at the outlet of the cylinder or other vessel from which the explosive mixture is being forced.

Some arrangement had, therefore, to be got which would fire the charge inside the engine cylinder, notwithstanding the compression. Perhaps the simplest flame-igniting device, which would do this was that of Barnett, brought out as far back as the year 1838. It consisted of a stopcock, having a hollow plug, in which was placed a small gas-jet. The plug had a long narrow port in one side of it, running lengthwise; and this port, when the plug was in one position, communicated with the air through a similar port in the barrel or shell. Here the jet was lighted by an outside flame, and at the proper moment (determined by mechanism connected with a moving part of the engine) the plug was turned through a quarter of a circle, when its port came opposite a port communicating with the cylinder, and fired the charge. This extinguished the jet; but it was relighted on the plug being turned back to its original position.

Otto's improvement in the firing of the charge consisted of a simple arrangement of a cavity and ports in the slide-valve, whereby he obtained a flame under pressure. This was brought about by admitting to the cavity in which the ignition jet burned a small portion of the explosive mixture from the cylinder, which gradually raised the pressure of the flame to that of the compressed charge. This arrangement was in use for many years, although not always quite satisfactory, especially at high speeds and full-power loads, as great difficulty was experienced in ventilating the small passages and cavity in which the jet had to burn. When we consider that ignition had to take place as often as 100 to 150 times a minute, according to the speed and load on the engine, we may admit that the clearing out of these small passages so rapidly was no easy matter.

The electric spark has also had its share of the inventor's attention; and many valuable arrangements have been brought out. They are all, however, dependent upon a battery and induction coil; and the electrodes exposed to the explosion are so liable to corrode, thereby causing much trouble, that this system has not come into general use—in this country, at least. It has, of course, its good points, which, in certain cases, are well worth the extra trouble involved in keeping the several parts in proper working order.

It was as a boon, therefore, that the hot tube came to assist the gas-engine one step farther forward; and many are the improvements connected with even such a simple part of the engine as the ignition tube. The first tubes used were made from ordinary ½-inch bore iron gas-pipes, either welded or closed by a cap at one end, the other end being screwed into the cylinder or some part communicating with it. So long as they are new, iron tubes give a good reliable form of ignition, and are still largely used. Owing, however, to the action of the continued heat, the composition of the gas, and the pressure of the explosion on the inside, they soon get choked up by a deposition of carbon. The iron becomes quite thick and brittle; and when fractured, it shows quite a crystalline appearance.

All sorts of alloys have been made and used for the manufacture of ignition tubes, in the endeavour to get some metal that would heat easily, keep clean internally, withstand compression and have lasting qualities. These points have not been attained with metal tubes, as they have to be made so thick that they are difficult to heat, and it takes a large amount of gas to keep them hot.

The use of porcelain for tubes was first tried by Watson in 1881, and has since been proved to be the best material for the purpose. The tubes have a drawback, certainly, in that they require more careful handling than metal tubes; but, once connected to the engine, and the joints made tight, they work admirably—tubes, after use for years, when taken out, being perfectly clean and apparently unchanged in any way.

The ignition-valve is, in my opinion, a most important feature in the modern engine. Many engines are still made which have the firing tube continually open to the cylinder; and the moment for explosion is timed by raising or lowering the bunsen flame, so that the tube is heated higher up or lower down as desired. With absolutely unchanged conditions, during the whole life of an engine, this method of regulation would, perhaps, be perfect. The burned gas and air left in the tube, if compressed to exactly the same extent each compression stroke, determines the position in the firing tube to which the fresh explosive mixture will be forced; and if the heated portion of the tube is properly adjusted, ignition will not take place until the full compression has been reached—that is, when the piston is full in, and the crank just passing the dead-point.

You will readily see, however, that we have many circumstances to deal with before we can ensure absolutely constant conditions. The compression which we depend upon to force a fresh charge up to the same height in the tube every time, may not (owing to the speed of the engine or to a leaky piston or valves) be always sufficient. Then the tube, unless made of some incombustible and incorrodible substance, will change its character and size. And, lastly, the continually varying conditions of pressure in the gas-mains will slightly alter the proportion of the charge, and possibly affect the bunsen flame, and therefore the heat of the tube.

With a timing-valve, we at once get rid of nearly all these difficulties. The distance from the cylinder to the tube can be made exceedingly short, so as to insure that even the most variable charge will reach the heated portion; and early firing is prevented by the timing-valve, which is opened mechanically as the crank passes the dead-centre. Besides, nearly all gas-engines are now fitted with an adjustable governor, so that the speed of the engine may be altered while running. If there is no timing-valve, the economy of the engine, should the speed be much altered from the normal, may be seriously affected; a higher speed causing early firing and knocking of the piston and connecting-rod, while a lower speed may cause slow firing and even miss-fires.

I regret that, owing to building operations for the extension of our works, I have been unable to prepare any special tests to lay before you, as our testing arrangements have all been upset. However, as there have been recently many exhaustive tests made and published by some of the highest authorities on the gas-engine, I do not think you will miss anything I could have given you, meantime, in this way.

With your permission, I should like briefly to refer to some of the improvements, chiefly connected with details, which my own firm have introduced. Our engine is of the usual Otto type, and is designed specially to render it as simple and reliable as possible. The explosion chamber at the end of the cylinder, into which the charge is compressed, has had our greatest attention, and we have tried many different shapes. The design we have at last adopted for this part is in the shape of a cylindrical cone. The base of the cone is next to, and of slightly larger diameter than the cylinder, which gives the necessary clearance for the end of the piston. The length is regulated by what is required to admit the exhaust-valve; while the small end of the cone depends on the space necessary for the amount of compression required. In this way we get as large and open a space as possible; so that the explosion is not choked or cramped. The whole charge also is confined in one space; there being practically no ports or passages in which the burnt

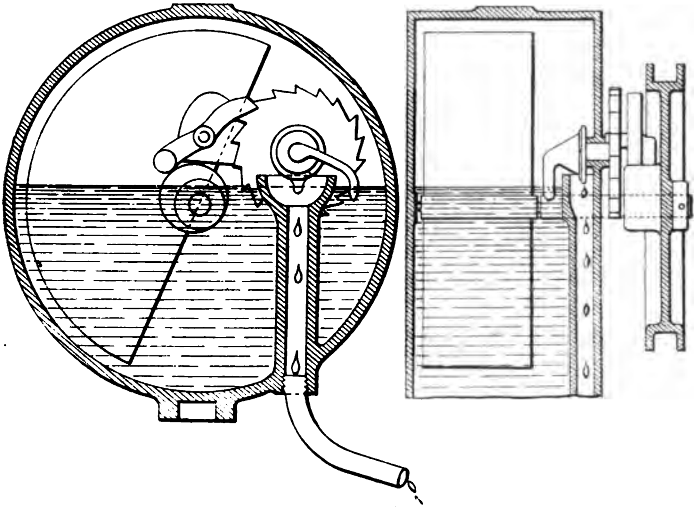

FIG. 16.--CYLINDER LUBRICATOR.

products may lodge. The inlet-valve for admitting the charge is placed directly behind the exhaust-valve on the centre-line of the cylinder; and it opens into a short cavity, the front of which freely communicates with the compression space, while at the back of the cavity is a small short hole leading to the ignition tube. The gas enters from the gas-valve, and, mingling with the inrushing air, both pass through the inlet-valve into the compression space, clearing out the cavity and tending to suck the burnt products of a previous explosion from the ignition tube.

The other points I would draw your attention to, and which, I believe, are quite novel, are the cylinder oiler, the ignition tube, the timing-valve, and the crosshead bearings in small engines. You will notice in the oiler your old friend the semi-cylindrical float, used by Sanders and Donovan for their wet gas-meters. The importance of absolutely constant oiling for the cylinder cannot be overrated, as the high temperature of the flame of the explosion soon burns off the thin film of oil on the surface of the cylinder; and if this is not continually renewed, cutting of the cylinder at once takes place. The float in this vessel keeps the oil always at the same height, so that

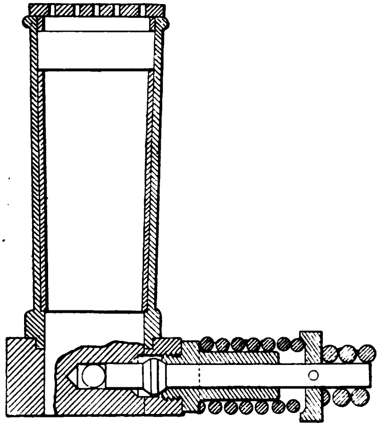

FIG. 17.—IGNITION-VALVE AND CHIMNEY FOR BUNSEN BURNER.

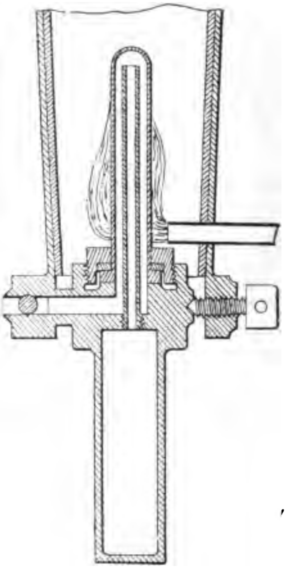

FIG. 18.—PORCELAIN IGNITION TUBE AND HOLDER.

the small rotating spoon, driven slowly round by the engine, receives exactly the same amount of oil at each revolution, and this continues during the whole time the engine is running.

The ignition-valve shown consists of a straight steel spindle, about ⅜ inch diameter, which closes and opens the passage from the cylinder to the ignition tube, when moved to-and-fro by a lever through a cam on the side shaft. It is sometimes astonishing what a small trifle prevents the regular firing of the charge; the least increase or reduction in the size of the ignition hole being sufficient to cause the charge to miss fire. The form of this valve allows of a perfectly straight hole from the cylinder to the tube, which is very important, as any bends or elbows are not conducive to sharp instantaneous firing. The valve is very loosely fitted, and just crosses the hole from the cylinder to the tube. During compression, the small portion of the fresh mixture, which passes the valve owing to it not being perfectly tight, gradually drives out all the products of the previous explosion into a chamber in the ignition tube holder. The valve-rod works easily in a long gun-metal gland; and, to prevent leakage, it has a double-faced valve turned upon it. The valve-rod is pushed in—not directly by the lever, but by means of a strong spring; and the inner valve-face prevents leakage during compression. At the moment of explosion the cam on the side shaft releases the lever, and the spring is withdrawn; while another spring comes into play and pushes back the valve-rod, closing the other valve-face upon its seat. This valve works well and gives no trouble. One has been in constant use in one of our engines for over three years; and, to my knowledge, it has not been taken out for any repairs or adjustment.

The ignition tube we have adopted is made of porcelain. It is unusually short, closed at one end, and the open end has a flange formed on its outside, by which a hollow nut secures it in position, in a specially constructed holder. A small metallic tube extends from the holder inside and almost to the top of the porcelain tube; so that the burned products of a previous explosion pass down this small tube into a chamber at the bottom of the holder, which allows the fresh charge to reach the heated porcelain. The small metal tube does not undergo any change, as it is never red hot, and the pressure on it is equal both outside and inside. This ignition tube has given great satisfaction; the ignition is most reliable, taking place with certainty at either fast or slow speed.

The difficulty of fitting small engines with adjustable brasses for the end of the connecting-rod in the piston is so great, on account of the small space available, that many engines are made without this provision at all. Consequently, when the least wear of the crosshead pin takes place, the only remedy is to fit in a new pin. To avoid this, we have reversed the order of things, by placing the adjustable brasses in the piston, and fixing the pin so that it turns with the rod. By this means, though a little costly at first, the smallest engine can be adjusted when wear takes place at the crosshead pin.

There can be no doubt that a great deal has yet to be done to improve the action of the gas-engine. The main direction in which a change must be looked for is, I think, in the cycle. But this would seem almost impossible without introducing complicated mechanism. At present—at least with the small sizes—the successful competition of the gas-engine with the steam-engine is chiefly due to the convenience and economy with which the gas-engine can be operated, especially for intermittent work. With engines above 40 or 50 horse power, using producer gas, the cost of working, as compared with steam, is very greatly in favour of the gas-engine, as has been proved time after time. We shall find, therefore, that the large gas-engines will not stop at 400 or 500 horse power, but increase gradually year by year, until they compete in power with the largest steam-engines made.

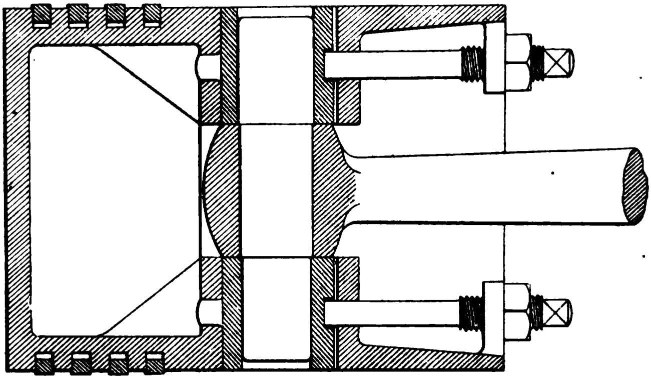

FIG. 19.—PISTON OF SMALL ENGINE, SHOWING METHOD OF TAKING UP WEAR AT CROSSHEAD.

What the gas-engine has done for the benefit of small masters, it is impossible to estimate. Many hundreds of these employers were driven out of existence by the introduction of the steam-engine. But they are gradually springing up again;

and, by the aid of the gas-engine, they are able to secure a respectable share of trade. That the gas-engine will rank in the near future as one of the chief sources of power there can be no doubt; and I would add, in closing, that as gas managers are chiefly concerned in the manufacture of the working fluid, they should do all in their power—by giving a plentiful supply, at a good pressure, and, if possible, at a reduced rate—to help forward this excellent motor to a greater extent of usefulness.

Discussion.

The PRESIDENT said they had listened to a very graphic description of the gas-engine; and if anyone wished to put any questions to Mr. Peebles, he would be pleased to hear him. He (the President) would like, for his own sake, to have had a comparison of gas power with steam power, if Mr. Peebles had been able to give it, as it would have been interesting to many of those present.

Mr. D. VASS (Edinburgh) said he should like Mr. Peebles to give them the working pressure which he found most serviceable. A gas-engine, as a rule, was required during the day, when they wished to keep their pressure as low as possible; and as this caused them to have their pressure extra low in some districts, it might not be serviceable. A hint from Mr. Peebles in this direction might be useful; and perhaps, also, he might give them something in the way of figures for the sizes of pipe required per horse power. This would be of service to anyone contemplating using a gas-engine.

Mr. J. NAPIER MYERS (Saltcoats) said he would join with others in thanking Mr. Peebles for his efforts to instruct them in the matter of gas-engines. One question arose in his mind with regard to supplying gas for engines, and it was which, in Mr. Peebles's opinion, was the best way to measure the gas for an engine—whether through a dry or a wet meter.

Mr. PEEBLES said, with regard to Mr. Vass's question, he considered the best pressure for working a gas-engine was about one inch. They, as a rule, arranged the different valves—at least his firm did—to get a supply at about an inch pressure. They knew what they got in this way. If the pressure went down below that, the gas-engine maker, in putting in an engine, had to reduce the air supply, in order to make the engine work satisfactorily with the reduced gas. The consequence was the cylinder did not get a complete charge of gas and air, and they were working with a reduced charge all the time. The effect on the engine was that they had not only a drag put upon it, but had also the reduced charge, giving them less effective power, at each explosion. He considered an inch pressure was, as a rule, easily obtainable during the daytime in good districts. But very often, through large consumptions in certain districts, by other engines being at work, by having small mains, and other things, pressures were much lower than that; and this had to be fought against. As to the capacity of the mains per horse power, there could hardly be a rule laid down, as it was a matter for individual and local consideration. The pipes up to the meter should be a good deal larger, if possible, than the connections of the meter recommended by the engine maker. It would be found an advantage in the case of large engines to put in the street, as near the engine as possible, a length (say) of 12-inch main-pipe, so as to form a reservoir from which the engine could easily draw its supply. This would also tend to reduce the pulsations occurring in the immediate neighbourhood, caused by the engine. He could give the members a list of the different meters his firm recommended for engines, which, he thought, they would find to be larger than the meters used by any other gas-engine maker. The reason they did this—and he thought he impressed this upon the members last year, in the discussion upon Mr. Pooley's paper—was that they considered the meters put in in the past by other manufacturers to be too small, owing to their not understanding the effect upon the meter of the sudden withdrawal of gas out of it. Of course, being meter manufacturers, they had the advantage of knowing the effect that would take place in the meter, which was this—and he had tested it—that at each draw of the engine, unless they had a large meter, they sucked in the diaphragm, and obtained more gas per revolution of the meter than it was actually intended to give. There was a certain space in a meter which was a constant, as it were—which was not emptied when the meter was working under ordinary conditions; but if they put on a gas-engine to draw the gas quickly out of the meter, they emptied this space, and emptied the meter beyond its normal condition, and thereby got gas for nothing. Mr. Myers asked whether it was better to measure through a wet or a dry meter. He should certainly say a dry meter, and for this reason—that, especially if the weather were at all warm, the water in a wet meter was apt to evaporate, and wet the gas. They had found this in an experiment they were recently making. They were trying to get a new anti-pulsator, and they got something which acted admirably. The idea was to use the water-vessel which was sent with every engine, and to put a bell into it; but they found, after a week's working, that the pipes were all filled with condensed water. He thought this answered Mr. Myers's question, and showed that a wet meter would not be a good thing to use. Mr. Wilson had asked for a comparison between the gas-engine and the steam-engine as regards cost of running. This was a very intricate question, depending on so many considerations. He thought that certainly the gas-engine had the advantage by a long way, especially for small powers. And it was the same for large powers, because producer gas then came into operation. For small powers, where coal gas was used, the gas-engine worked out, as a rule, at 1d.—sometimes ¾d.—per brake-horse-power per hour. They would very seldom find a small steam-engine working for anything less than 2d. or 2½d., which showed a considerable difference in favour of the gas-engine over a steam-engine.

Mr. W. FOULIS (Glasgow) asked what was the price of coal and of gas.

Mr. PEEBLES said gas at 3s. per 1000 cubic feet, and coal at 10s. per ton.

Mr. J. HEPWORTH (Edinburgh) read the last paper, on

THE COWAN PRESSURE SYSTEM.

What is known as the "Cowan Pressure System" was introduced a few years since; and, as there may be some who are not acquainted with its objects, the writer, when applied to for a short paper, decided to offer a few notes thereon. The system having already been described in one or more of the technical journals, and having been treated of in a valuable paper on "The Automatic Regulation of Pressure in the Distributing Mains," read before The Gas Institute in 1897, any detailed description of the apparatus is unnecessary.*

The governor for regulating the pressure of gas, as is well known, was devised and first employed by Mr. Clegg, in conjunction with the first gas-meter. Shortly after its introduction (the governor having assumed a more practical form), it was adopted for regulating the pressure at which gas is delivered from the gasholder into the mains supplying the town. The gas-governor, when properly constructed, has been found to answer its purposes so well that it has probably never occurred to many of those using it, that any future addition to it for improving its efficiency would be either necessary or practicable.

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* An illustrated description of the apparatus will be found in the *Journal of Gas Lighting*, Vol. LXX., p. 26.

The "Cowan Pressure System" is not a governor. It is really an adjunct to the governor; and by its instrumentality the pressure of gas in the town or in a certain district is perfectly controlled and automatically maintained. It performs a duty which has not yet been performed by any governor.

The gas-governor in common use requires attention whenever an increase or decrease of pressure is necessary. If the governor is to be of any service, the bell must be loaded or unloaded as the consumption of gas increases or decreases at intervals during the twenty-four hours of the day. The necessity for altering the load is due, not to the necessity for any increase of pressure in order to secure the perfect combustion of the gas, but solely to the inadequacy of the carrying capacity of the mains. The mains are always more or less inadequate to convey the requisite quantity of gas during periods of greatest consumption; and they must always be so. Therefore the loading and unloading of the governor is obviously necessary. The operation of loading and unloading is usually effected by hand; and, provided that this operation is always attended to at the right time, and performed to the required degree, the results ought to be fairly satisfactory. But what is the right time is not easily ascertained; nor is it possible always to settle upon the requisite degree. Arrangements were devised more than 20 years since for increasing and decreasing the pressure mechanically. This was effected by the aid of clockwork; and it has been found a successful method up to, and within, the limits of its powers. All the attention required by this system was the winding up of the clock attached to the pressure changer, and the adjustment of this changer once a week, so as to increase or decrease the pressure to whatever extent, and at whatever time, it might be desired.

Whether the load is applied manually or mechanically, the pressure, be it remembered, is fixed and controlled in the governor house. Is this the most satisfactory point from which to regulate the pressure? Are we not all familiar with occasional complaints, perhaps not of bad gas, but of a defective supply of gas or an inadequate pressure in some part of the district supplied? What have we done to remedy the complaints? Probably, in some instances, we have appealed to the pressure register; and, if we have found that the registered pressure at the outlet of the governor was the same as usual, have we not folded our hands and concluded that there was no ground for the complaint? Or, if we have had any doubt in the matter, we may have concluded that a permanent increase in the pressure would prevent future complaints; and we have taken steps to secure this. In either case, we may have come to the wrong conclusion; for there may have been an actual deficiency of gas for a time in the district from which the complaint was received—a deficiency arising from some unusual local demand. Such unusual demands do arise, and may be caused by a dense fog, or by a sudden, a temporary, and a somewhat erratic demand for gas, either for lighting, cooking, heating, or industrial purposes. A sudden deficiency in the supply of gas in a remote district is not immediately, and never fully, made known at the gas-works; and as the governor cannot of itself supply the additional load which would enable it to respond to the increased demand, the deficiency is probably never known at all until after the demand has ceased. In such a case, therefore, the complaint of a deficient supply is well founded. But to remove all cause for such a complaint, there is no necessity to increase permanently the pressure of gas at the outlet of the governor. Indeed, this probably would, in its turn, prove as inefficient, as it certainly would prove an undesirable, remedy.

Now, it is at this point that the "Cowan Pressure System" comes in. The principle of this invention consists in "automatically regulating the loading and unloading of gas-governors by the pressure of gas in the main of a district remote from the governor." If this principle is the correct one to apply in the distribution of gas, then it follows that the governor is after all not the most satisfactory point from which to regulate pressure; and that, as a matter of fact, it is impossible to regulate the pressure at the governor so as to afford an adequate supply of gas under all the varying circumstances that arise. Whatever form of governor is used in connection with this apparatus, it is more convenient to employ water as the loading medium. The apparatus includes: (1) The pressure vessel. This consists of a tank and float-bell or small gasholder balanced by the gas pressure and placed in any convenient building wherever (after examination) it is found that the pressure of gas is lower than in any other part of the district. This pressure vessel is connected with the gas-main by a short length of pipe. (2) An electrical apparatus fixed in the governor house, for operating the valves which load and unload the governor bell. (3) A water-tank constantly supplied with water through a ball tap. (4) The necessary wires connecting the pressure vessel and the electrical apparatus referred to. [A more complete description of the apparatus is added as an appendix.]

The apparatus being fixed and in operation, what occurs? The pressure may be whatever we determine; but we will assume that it has been determined that the minimum pressure of gas should be 12-10ths in the district where the pressure vessel is fixed; and that the apparatus has been adjusted to give this pressure. What occurs when a heavy and sudden demand for gas arises in the district? The pressure of gas is immediately reduced to something below the 12-10ths fixed upon. That, so far, is precisely what would have occurred if there had been no pressure vessel at all; and it is precisely what does occur wherever the pressure system is not in use. But, immediately the bell of the gasholder falls, the valves in the governor house are operated electrically, and the load upon the governor is at once restored so as to give 12-10ths. In the same way should the pressure in the remote district ever exceed 12-10ths, the valves are again operated electrically; but this time with the result of promptly decreasing the pressure again to 12-10ths.

The writer, having had the system in use when he was engaged in the management of gas-works, is able to say from experience that no instrument could act with greater precision and accuracy in effecting the purpose for which it was designed. To an Association whose members are always ready to appreciate whatever methods are introduced for improving either the manufacture or distribution of gas, it can scarcely be necessary to enlarge upon the advantages of the pressure system now briefly referred to. It secures a constant and efficient pressure in the district where the pressure vessel is fixed, and this ensures a sufficient pressure over the whole district supplied. The pressure is obtained without personal attention, and with the certainty that, however irregular the demand for gas may be, the instrument will promptly and satisfactorily meet it. The apparatus will be found to reduce the average pressure at the outlet of the governor; and, when the pressure is increased, it will only be for so long a time as is necessary. The consumer will always get a sufficient quantity of gas, however, and whenever his requirements may vary. A reduction in the unaccounted-for gas will naturally follow. The necessity for a costly expenditure in larger mains may, in many cases, be avoided. No governor known to the writer is able to secure the results obtained by this invention.

It is quite possible that some objections to the system may have arisen in the minds of some persons, and some of these may be anticipated.

The present system of controlling the pressure from the governor is sufficient.—It has already been pointed out that, under the present system of controlling the pressure of gas at the governor house, no provision whatever exists for increasing the pressure in response to any unusual and increased demands for gas which may arise in certain parts of the district, and however occasioned—all of which may be unknown at the governor house; or, on the other hand, for the immediate decrease of pressure when this demand ceases. Further, it is found in practice that, where "Cowan's Pressure System" is in use, the pressure is frequently not required until a later time than had been previously supposed, and is, therefore, not put on so early; and also that it is often unnecessary to keep on the pressure as long as had been thought necessary, when it is therefore taken off earlier.

The results secured by the "Pressure System" could be secured by simpler means.—No such means are known to the writer.

Self-loading governors may do the work this system does.—Those who hold this view overlook the conditions of the problem to be solved, and cannot be acquainted with the principle on which the action of "Cowan's Pressure System" is based. The sympathies of self-loading governors are local, and do not extend far into the district. Consequently, changes of pressure occurring, it may be, miles away from the governor meet with little or no response. As no change of the governor pressure can precede a change of load, and as a change of load can only be ensured by comparatively local influences, it follows that the supply to remote districts is, in the case of self-loading governors, dependent on nearer districts, instead of nearer districts being dependent upon remote districts, as is the case with the Cowan system. It is simply impossible that any self-loading governor can do the work this system does, because the latter is in constant touch with the necessities of the worst supplied part of the district, and maintains a constant and unvarying pressure there. This pressure may, of course, be of any required degree, and may be changed when required without any difficulty or loss of time. In this way the whole of the district is fully provided for at all times and under all circumstances.

If a constant pressure be maintained at the lowest level or worst supplied part of a district, the pressure in the high levels during the heavy consumption will be greatly in excess.—Now, if it be necessary during the heavy consumption to give, say, 12-10ths pressure at the lowest level, and, in giving this 12-10ths, it requires that

30-10ths or 35-10ths pressure be given at the governor, it will at once be admitted that the higher pressure on the higher levels is inevitable if the pressure of 12-10ths is to be maintained in the lower district, and is precisely the same pressure whether put on by hand or by this system; the difference being that, under the "Pressure System," every consumer will get his gas at a sufficient pressure, whereas under the ordinary system this, if not impossible, is, to say the least, doubtful.

The employment of electricity to bridge the distance between the pressure vessel in the district and the governor in the gas-works may be urged as an objection. Electricity is, of course, not the only means of communication that has been and may be employed under this system; but it has been found to be the most convenient as well as the most effective. It may have been supposed that the gas supply under this system depends absolutely on the perfect working of the electrical arrangements; and, on this ground, some fear may have arisen as to the result of employing electricity in connection with the system. The objection, however, has no real foundation. The stoppage of the electrical current would not interfere with the governor load; and, in any case, such an event would leave the governor as free as any other governor to be operated by hand in the usual way. And, with reference to the idea that the interruption of the electrical current might be a thing of frequent occurrence, it should be borne in mind that the whole system of railway signalling is dependent upon electrical agency; and this consideration might surely inspire confidence in the use of electricity in such a case as the system now under discussion, where there is really no risk at all from the employment of the same agent.

One other question may possibly have arisen, though not quite in the nature of an objection—*viz.*, if the pressure is controlled from the lowest part of a district, will it not be necessary to change that given pressure to suit the various consumptions? If the system accomplishes what it proposes, this will not be necessary, and in practice it has been found to be altogether unnecessary. If it were necessary, however, the pressure could be changed very readily as often as might be desired. It requires only a moment's consideration, however, to see that if the minimum pressure of 12-10ths, or any other minimum pressure that may be thought desirable, is maintained in that part of the district which is the worst supplied, every other part of the district must, at all times, be receiving its gas at an ample, but never at an excessive, pressure.

APPENDIX.

A Short Description of the Apparatus Employed in the "Cowan Pressure System."

The apparatus consists of—

(1) A governor arranged for water loading.

(2) A pressure vessel or small gasholder connected to the main in the lowest pressure part of the district.

(3) A board placed in the governor house on which are fixed two electrically controlled water-valves for loading and unloading the governor.

(4) A small water cistern fitted with ball-cock for supplying water-load to the governor.

(5) Connecting wires between the pressure vessel and the electrical apparatus, for operating the water-valves.

(6) The battery for supplying the electric current, composed of ordinary Leclanché cells or accumulators.

The working of the apparatus is as follows: Immediately the pressure is reduced in the district by an increased consumption, the bell of the pressure vessel falls, and, in so doing, makes an electric contact by means of an arm fixed to the bell coming in contact with another arm attached to the tank. This contact completes an electric circuit between the pressure vessel and the water-supply valve, which then opens and supplies water for loading the governor, until the pressure in the district is brought again to the standard pressure. Immediately this pressure is attained the bell rises, breaks the electric circuit, and allows the water-supply valve to close. As the pressure in the district increases by the consumption decreasing, the bell of the pressure vessel rises; and in rising it closes another electric circuit by means of another set of arms. This opens the syphon valve, and allows water to run off until the pressure is again restored to the standard fixed.

Discussion.

The PRESIDENT said they were all very much indebted to Mr. Hepworth for the time and care taken by him in bringing the subject before them. The paper was a very instructive one. He had now come to a stage where he could not do without a governor; and it came to be a question which was best. He had a feeling much the same as that expressed in the last paragraph—namely, was electricity the best agent for changing; but Mr. Hepworth got over that by saying that if electricity was used for signalling on railways, they might adopt it too.

Mr. W. FOULIS (Glasgow) did not think there could be any doubt that there was a great deal of ingenuity displayed in the invention. Of course, he had had no experience whatever of it in practice; neither had he given any attention to its working. But he doubted very much if it would be an instrument that would be suitable in all cases. He did not know whether Mr. Hepworth's suggestion was that there should be a number of these pressure vessels, scattered through the town, at different places where the pressures were likely to be low. This would mean, of course, that each of the districts would require a separate main, and a separate governor at the works, to be controlled by the system. There could be no doubt that the point at which the pressure should be maintained was the lowest part of the town—that was to say, they should maintain the pressure sufficiently there, and then, of course, they would be sure that their pressure would be sufficient in all the other districts. In Glasgow they had succeeded fairly well, by having telephonic communication with different offices in various parts of the town; and the pressures were telephoned from there to the works where the station governors were. The instrument before them did automatically what they in Glasgow did by means of telephone messages.

Mr. J. M'Gilchrist (Dumbarton) said that, with regard to the pressure-changer, he should like to hear how it would operate in a town where the gas-works were at the lowest point of the district. He saw quite well the force of having the pressure-changer if the governor, or the gas-works, were situated at a higher elevation than the lowest part of the town. In his own case he did not see how it would be of any service, because the gas supply was from the lowest part of the town.

Mr. A. Waddell (Broughty Ferry) said he should like to thank Mr. Hepworth for having brought this matter before them. They all knew of the need they had to have their pressure kept as uniform as possible at all times; and they were all aware of the trouble they had through people in one part of the town saying they had very bad gas, while those in another part declared that it was very good—the gas being the same all the time, and the only difference being (although the people did not know it) in the pressure. In his own case, a complaint recently came from a certain part of the town. He went to the place and took the pressure during the day. It was in an elevated position, and the pipe running through the district was a small one. He found something like 22-10ths pressure during the day time. He went back and took the pressure at night, when the heavy consumption was on, and then he got 12-10ths. Since that time he had relaid the main, and the complaints in the district had ceased. This showed that it was not, as they all knew, uniformity of quality alone that was needed, but uniformity of pressure also was wanted.

Mr. M'GILCHRIST: Perhaps Mr. Hepworth, in considering this matter, will take into account the fact that we go on the principle of having a large main and a low pressure.

Mr. A. BELL, sen. (Dalkeith), said he was sure the members had been very much indebted to Mr. Hepworth for reading the paper. It had been complained that some of the papers read that day had gone over the heads of most of the managers in Scotland. It was well that they should be so; for such papers acted as a sort of ferment, as it were, in the minds of managers. This was very much the case both with Mr. Little's conveyors and Mr. Hepworth's pressure-changer. In all large and well-appointed works, they had district mains, with a governor controlling each; whereas in small works they had just one great supply main for the whole. The instrument before them, therefore, would not be of very much benefit, unless there were great variations in the elevation.

The PRESIDENT said he supposed that, from the description given by Mr. Hepworth, the principal saving or advantage in the pressure-changer was the doing away with the attention of some individual, located in different situations, such as in Glasgow, keeping up telephonic communication. He supposed this was the principal advantage. There were instances where the levels might vary in a town—say, from sea-level to about 250 feet. In his own case there was a variation of 150 feet. He did not know how the pressure-changer would act in such a case. They were supplying a level 150 feet below the gas-works, which would be 1½ inches of pressure; so that they would have an extraordinary pressure at some of the higher places. He fancied that a district governor in his case would get rid of any difficulty.

Mr. HEPWORTH expressed his obligation to the members for the patience with which they had listened to his paper; and, in reply to the questions which had been put during the discussion, he thought he might say that it would appear that the object of the instrument had been, at all events, understood perfectly well by those who had followed him. As Mr. Foulis had said, it would be necessary to take into account the low districts. He supposed that if they had a large town, supplied by three, six, or thirty governors—as many as they pleased—they would probably have each governor supplying its own district. One governor would not work in with the next. If they had a town districted in this way, it would only be necessary to have one of the pressure vessels in every district, at the lowest part—he meant the worst supplied part—and it would be sufficient to cover the wants of the other parts of the district. They were aware that in large towns the inconveniences of sudden local demands had been met by the use of the telephone or the telegraph; but, of course, it was for everyone to judge for himself. Provided the person at the telephone office in the district knew of the want which had arisen, he could go and make his wants known, and they would be at once attended to. But he (Mr. Hepworth) had a case in his mind—and there might probably be a great many others—where for certain industrial purposes gas was used very largely intermittently, and at times which could never be arranged beforehand, no one outside the place knowing that the demand had arisen. Every time this demand arose, the instrument would immediately indicate to the governor at the gas-works that it had arisen; and until the demand was met and supplied it would go on asking for gas to be sent. This, he thought, was perhaps the best way in which the advantages of such a system could be seen to be even greater than those of the telephone or telegraph.

Mr. Foulis: Would you have the instrument placed outside the works in that case?

Mr. Hepworth: Yes.

Mr. Foulis: It would be rather awkward, would it not?

Mr. Hepworth said presumably that would be the worst part of the district. Mr. M'Gilchrist had spoken of his works being in the lowest part of the town. He believed this was the case with most gas-works; but no one who had his works at the lowest level of the town—at least he should think there were few, if any—would say that the pressure he had at that level was one he would be always able to give, or wanted to give, at some other low level in the district he supplied. But, in any case, if there were a deficiency in any part of a district or town which had its gas-works at the lowest level, the deficiency would, by this instrument, be immediately made known at the works, and be promptly supplied. Whether or not there was a man to supply it, the pressure would be put on. It was, as Mr. M'Gilchrist had said, desirable that they should provide large mains rather than have high pressures; and, of course, most engineers managed to do this as soon as they were able. But, as he said in his paper, the mains somehow were always becoming insufficient to convey the gas that was wanted. The consumption went on increasing; so that a main which might be perfect that day would be almost sure to be a little imperfect that day week, and still more so that time next year. Whatever comparison or difference there might be between the wants of a district and the supply arrangements, the wants would be met by the instrument he had described. The President had said that probably its value might consist in dispensing with the attention of a few persons employed in looking after the governors. This might be the result; and it certainly would be, so far as any necessity or demand for gas arose, because no man need look after the governors if he had the pressure system. But he did not think the value of an instrument like this could be computed in that way. The value of it, he thought, was that, while it might do away with the attention of the man in charge of the governor-house (who might not come in just at the right time), it did more, for it enabled the manager to feel quite sure that, whatever might or might not fail him at that or any other point, an extra quantity of gas would be supplied, if needed, at any given place. The instrument brought the intelligence home to the works; and the required supply of gas was afforded.

ELECTION OF OFFICE-BEARERS.

The result of the ballot for office-bearers was as follows :—

President.—Mr. Hubert Pooley, Dunfermline.

Vice-Presidents.—Mr. W. Ewing, Hamilton; Mr. J. Carmichael, Barrhead.

Secretary and Treasurer.—Mr. R. S. Carlow, Arbroath.

Members of Committee.—Mr. W. R. Herring, Edinburgh; Mr. J. M'Gilchrist, Dumbarton; Mr. J. Wilson, Tradeston Glasgow; Mr. A. Yuill, Alloa.

PLACE OF NEXT MEETING.

The meeting next year was fixed to be held at Stirling.

THE PRESIDENT'S MEDAL.

Mr. A. BELL (Dalkeith), as the last preceding President, presented Mr. Wilson with the President's Medal.

The PRESIDENT acknowledged the gift, and the proceedings closed.

THE DINNER AND EXCURSION.

The members and friends afterwards dined together in the North British Station Hotel, under the presidency of Mr. Wilson; and the next day there was an excursion to Lochranza.

NORTH OF IRELAND ASSOCIATION

ANNUAL MEETING, AUG. 9.

This Meeting was held in the Young Men's Institute, Portadown, Co. Armagh, under the presidency of Mr. J. NISBET, the Manager of the Portadown Gas-Works. The members, of whom there was a larger attendance than at any previous meeting of the Association, assembled in the forenoon, and most of them paid a visit to the gas-works, which were found in a very trim condition.

The business commenced shortly after eleven o'clock.

The PRESIDENT said Mr. Thornton, the Chairman of the Gas Company, intended to have been there at that time to welcome the members to the town, and to invite them to luncheon in the afternoon; but, unfortunately, he could not make it convenient to do so, but would be present at the luncheon.

REPORT AND ACCOUNTS.

The HON. SECRETARY (Mr. James Whimster, of Armagh) read the report of the Committee. It commenced by expressing regret at the loss sustained by the Association through the removal by death of two of the oldest members—Mr. M. Martin, of Drogheda, and Mr. D. M'Callum, of Omagh—who, though both advanced in years, were regular attendants at the annual gatherings. The subjects of standardizing meter-unions and the Workmen's Compensation Act, 1897, had been brought under the notice of the Committee by the North British and North of England Associations respectively, and would be discussed at the meeting. The Committee regretted that the offer of medals for competition papers had borne so little fruit—only one paper having been sent in last year, and none this. It was suggested that the meeting should decide as to the advisability of continuing the offer. The accounts accompanying the report showed a balance in hand of £20 17s. 7d. The membership stands as follows: Ordinary members, 54; extraordinary members, 20; honorary members, 2—total, 76.

Mr. T. FRIZELLE (Holywood) moved, and Mr. A. GIBB (Newry) seconded, the adoption of the report and accounts.

Mr. D. WILLIAMSON (Clones) suggested that the Secretary might be instructed to formally express the sympathy of the members with the relatives of the two deceased members.

The SECRETARY explained that he attended the funerals of both members as the representative of the Association.

Several members having testified their appreciation of the valuable services rendered by the two deceased members, it was resolved that the minutes of the day's meeting should contain a formal expression of the deep sense of loss which the members felt by the death of their colleagues.

The report and accounts were adopted.

The HON. SECRETARY said he received a telegram from Professor Macadam on the previous day, expressing his regret that he could not be with them; and he had since had a letter confirming the telegram. [Mr. Whimster read the letter, in which Professor Macadam explained that he had just returned from Aldershot, and was under orders to report on the Camp in person on the day of the meeting.] They were all very sorry Professor Macadam could not be with them; but it was a matter which could not be avoided.

NEW MEMBERS.

The following were admitted to the Association :—

Ordinary Members.—Mr. R. Campbell, of Carrickfergus; Mr. John G. Tooms, of Carrick-on-Suir; Mr. R. Bruce Anderson, of Westminster and Kilkenny; Mr. W. Barnett, of Roscommon; Mr. P. Maguire, of Cavan; Mr. M. Morgan, of Navan; and Mr. G. W. Young, of Carlow.

Extraordinary Members.—Mr. H. Allender, of London; Mr. Thomas J. Cotton, Inspector of Lighting, Dublin; Mr. J. Clark, of Meters Limited, Glasgow; Mr. J. T. Harvey, of Belfast; Mr. A. W. Lyon, of London; Mr. J. Slight, of Glasgow; and Mr. S. W. Tamplin, of Manchester.

ELECTION OF OFFICE-BEARERS.

Office-bearers were next elected, as follows :—

President.—Mr. J. Auchterlonie, of Mullingar.

Vice-President.—Mr. G. R. Love, of Dundalk.

Hon. Secretary and Treasurer.—Mr. J. Whimster, of Armagh.

Committee.—Mr. A. Gibb, of Newry; Mr. C. B. Tully, of Sligo; and Mr. S. B. Langlands, of Coleraine.

PROPOSED PRESENTATION TO MR. WHIMSTER.

Mr. T. **LLEWELLYN** (Newbridge) said he would crave permission to remark that Mr. Whimster had now served them for eleven or twelve years, and it was, he thought, time the members rendered him some token of their appreciation of his services to the Association. He moved that steps should be taken to this end.

Mr. T. **FRIZELLE** (Holywood) expressed his great pleasure in seconding the motion. He said Mr. Whimster was the originator of the Association, and had been the life and soul of it. He had kept the members together, and during the twelve years had done a great amount of work for them; and he (Mr. Frizelle) thought the least the Association could do would be to recognize his services in some tangible form.

Mr. **WHIMSTER** said he had to thank the members very much for so cordially appreciating his services, and for again appointing him Secretary. He would have been glad, after twelve years' service, and seeing that the Association was, as he might say, pretty successfully floated, if they had relieved him of the office, and appointed a younger man to take up the burden. It was not, however, that he had any wish to throw it off. He liked the work and the Association; and he was glad to see it prospering. With reference to their gold medal competition, he wished to say that the offer of a gold medal had put him in a fix, because it was left till the 1st of July to send in competition papers, and until then he could not tell whether there were to be any or not. Therefore the time was too short between then and the second Tuesday in August for him to provide anything else, if no papers came forward. With reference to the proposal to recognize his services, he would much rather that they would not say anything about it.

Mr. P. **HURLL** (Glasgow) thought it would be only fair that they should do something to show their appreciation of Mr. Whimster's services; and he suggested that a small Committee should be appointed to put the matter into form.

The proposal was adopted, and a Committee appointed, consisting of the President-Elect (Mr. Auchterlonie), Mr. Llewellyn Mr. Gibb, and Mr. A. Mackenzie, of Edinburgh.

THE PRESIDENT'S ADDRESS.

The **PRESIDENT** then delivered the following

INAUGURAL ADDRESS.

In addressing you for the second time as your President, I do so with mingled feelings of pleasure and regret; pleasure at meeting once more with so many brother managers and friends, and regret at the loss of two of our oldest members—I refer to the late Mr. D. M'Callum, of Omagh, and Mr. M. Martin, of Drogheda. Both of them were with us at our meeting in Omagh last year, and both have been taken away from among us by death. Those of us who knew those members best know the deep interest they both took in the affairs of the Association from its very first formation.

I am glad to be able to say that, both numerically and financially, our Association is in a very healthy and flourishing condition. Our membership is steadily increasing; and I have reason to believe that our meetings and discussions from time to time have drawn us together in a closer bond of brotherhood, and have been beneficial to us one and all.

One circumstance which shows that managers are beginning to understand the advantages of joining our Association is that there are now a considerable number of our members from the South and West—from as far South as Bandon and Skibbereen, and as far West as Galway and Tralee. Still there are a good number outside yet, who would I believe find it to their advantage to join us. Let no one think he has already learned as much of his business as he will require; for in this progressive age something new is turning up almost every day, and anyone who has a desire and ambition to better his position in life must study hard, and work hard, to keep himself acquainted with all improvements as they come out. If he does not, he will not succeed; for I can assure you there is a great deal more required from a gas manager now than there was a few years ago. If we take a glance back, say fifteen or twenty years (in small works, more especially), we see that, if the manager made the gas and distributed it in sufficiently large sized pipes to the various parts of the town, he had done nearly all that was expected from him. But now, if he is going to compete successfully with the electric light and with cheap oil, he must know and do a great deal more. He must know how to work generator and regenerative furnaces, so that he may get the best results both as to the quantity and the quality of his gas. He must know how to make the very best of his residuals. He should know how to make sulphate of ammonia. And within the past few years another new branch has come upon us—that is the supplying and fitting-up of gas cooking-stoves, fires, laundry-irons, &c. The manager must also know and be able to explain to consumers about the great variety of burners that are now competing one against another. To be able to do these and a great number of other things which I have not mentioned, but which must be dealt with as they arise, I know of no better method than to join our Association, and take as active a part as possible in its business. I would, therefore, for your own benefit ask you all to take a still greater interest in the affairs of our Association.

The gas industry, in the face of all opposition, still holds its place in the forefront of all competitors for the supply of artificial light. And every week as we receive our technical journals we read of some new departure in the apparatus for manufacturing, distributing, or consuming gas. And as I presume you all get these journals, it makes it difficult for me to bring anything before you that you have not already read or heard about; for although ours is the only Gas Managers' Association in Ireland, there are no less than seven kindred Associations in England, and three in Scotland, where papers are read and discussed on every subject connected with the manufacture and distribution of gas. In a great majority of cases these papers are contributed by managers of large works, who have had long experience, have better apparatus for experimenting with, and last, but not least, more time at their disposal than most of us, who personally must superintend every detail from the retort-house to the burner.

Coal has been comparatively cheap for the past two or three years; and as the selling price of every manufactured article mainly depends upon the cost of the raw material, and, as we all know, the cheaper an article can be sold the greater the consumption, therefore gas companies, like other manufacturers being always anxious to extend their business, have from time to time reduced the price of gas, until now I think I may safely say gas is sold all over the three kingdoms cheaper than it has ever been before.

But, unfortunately, this season there is another miners' strike —this time in Wales; and the coalowners have higher wages to pay. Besides, like all other employers of labour, gas companies included, since the coming into force on the 1st of July of the Workmen's Compensation Act, they have to take into account, and provide for, the extra liabilities they are now under. To meet all this extra expense, coal has gone up in price from 6d. to 1s. per ton.

There is also this year a considerable advance in the price of retorts, bricks, and all fire-clay goods. These increased prices will tell heavily, especially against small works, where the price of gas is now as low as it can be, consistent with the proper maintenance of the works, and the payment of the ordinary dividends to the shareholders.

It is a pleasure to us when we can announce a reduction in price. When we do so, our consumers are pleased, although not perfectly satisfied; for if the reduction is 5d. per 1000 cubic feet they will tell you that it should have been 10d. But when coal, fire-clay goods, wages, &c., rise in price, and the price of gas must be raised to enable us to get ends to meet, then something like a rebellion arises, and our consumers economize in every way they can. Some will take to electric light, if they can get it, although it would cost them a great deal more money, and some will take to oil, with all its trouble and bad smell, rather than pay the increased price for gas.

Well, this is a state of things we must do our very utmost to avoid. There are a number of ways which we can take to do so. And first, I will say let us do our utmost to make gas as popular as we can, not only for lighting purposes, but let us push the sale and hire of cooking-stoves, fires, laundry-irons, &c. I have a good number in Portadown; and I find that where a gas cooking-stove has been introduced into a house, it is very seldom returned. To push this business, a good deal of time and tact are required. One must be able to show the people how to use them, and how to use them economically. It takes time and patience—more, indeed, than sometimes we can well spare; but in the end it pays. When fitting up a cooking-stove, be careful to let the good lady of the house know that it is a stove for cooking with. I well recollect the very first cooking-stove I fitted up in Portadown. There was a meter for it independent of the house lights; the object being to ascertain exactly what the cost of cooking would be. The first account was very large. I was sent for, and heard the usual tale of how little had been cooked with it, and that the stove must be wrong, or the meter, or both. They had read in the papers about a dinner being cooked for 2d., and theirs was a long way beyond that; they must quit the stove, &c., &c. But after a bit of manœuvring and questioning, I discovered that not only had all the cooking been done upon the stove, but water had been boiled on it for the family washing and washing of floors also. I had to explain that the stove would do all that, but that was not cooking. Needless to say, the next account was not so heavy.

Another thing we can do is to introduce prepayment meters. There is a very wide field for them, because they are suited, I may say, to an almost entirely new class of consumers, and can be fitted with advantage to very small houses or shops. I have a considerable number in Portadown, and am adding to them. Most of my prepayment consumers were burners of oil, and now they tell me that they would not like to go back to oil again. We are to have a paper from Mr. Ross, of Dungannon, on prepayment meters; and I am certain we shall benefit by his experience, which he will freely give us. So, therefore, I will say no more about them, only this: Fit up as many of them as you possibly can in houses and shops where oil is used.

And as we try to extend our business by supplying cooking-stoves, prepayment meters, &c., we must certainly not overlook the apparatus inside the works gate. Get the best apparatus you can, and when you have got it do not neglect it, but keep it always in thorough repair and working order. I hold that if a works will not pay to be kept in thorough working order, you need not expect it to do so if you neglect it.

And do not overlook the distributing plant; for it will not pay to make gas, and let it escape through badly laid main and service pipes. One great enemy—I might say the greatest—we have to mains and services, is the traction-engine. No doubt it is a great convenience in a large number of ways; but when we see it passing along our streets dragging a huge steam-boiler, or a string of heavily-loaded trucks, how we tremble for the safety of our pipes which it is passing over. Not only have we the trouble and expense of repairing them when broken, but there is the risk of escaping gas getting into drains, and doing great damage, even to the loss of life, as was the case in Drogheda some two years ago. To prevent this as far as possible, mains and services should be laid as deep as can be, so that there is a fall to the water traps. It cannot always be done; but where possible mains should not be less than 2 feet from the surface.

We all know that, however careful and painstaking we may be to give our consumers the very best and purest gas we can make, our efforts are often frustrated by the way consumers use it, or rather, I should say, misuse it, after it has passed the meter, and is beyond our control. If meter-rents are charged, they will, to save the extra rent, insist upon a 2-light meter, when it would require a 3-light to pass the quantity of gas sufficient to properly light the house or shop. And in the same way they insist on a 3-light meter when it should be a 5-light, and a 5-light when it should be a 10-light, and so on in proportion. Of course, the meter cannot do it; and they blame the gas. Another cause is small pipes badly laid. Houses and shops are nearly always gas-fitted by contract—the lowest estimate taken. Pipes are laid in the quickest and easiest way. All may do well for a short time, but soon water gathers and the lights begin to jump; or a few more lights may be put upon the already too small pipes and overtaxed meter. No consumer ever thinks of blaming himself for having taken the lowest estimate, nor the gas-fitter for not doing his work properly. But again the cry is "Bad gas." It has often been said that gas companies should take gas-fitting into their own hands. If they did so, I believe it would be for the benefit of the consumer as well as the gas company. But I for one would not like to incur the risk; for now under the Workmen's Compensation Act I am afraid they would be accountable for a very great deal more than they will be if every consumer fits his premises by his own gas-fitter. This is a new Act; and as yet we have no experience of its working. Mr. Gibb, of Newry, has been studying it, and will open a discussion upon it, when we shall better understand its provisions. If gas consumers could be got to pay more attention to their pipes and fittings, and to use the best lamps and burners, we would soon cease to hear the oft-repeated cry of "Bad gas," and the consumer would have a better light for his money.

We very often hear the phrase used—"Educate the people, educate the people." I perfectly agree with that. Yes, educate the people. And more especially would I rejoice if we could educate gas consumers, whether they be town commissioners or private individuals, to understand that gas companies are always willing to supply them with any quantity of gas they require, provided always they pay for it. And if their houses and shops are not properly lit, the fault is their own, and not the gas company's. The same applies to the lighting of our public streets. Let the ratepayers understand that the efficient or the inefficient lighting of the streets does not lie with the gas company, but with themselves, through their representatives, the town commissioners.

I observe that inclined retorts are being adopted in quite a number of large works in England, and are giving great satisfaction. They, however, are not suitable for small works such as ours. I believe the generator or regenerative system is better suited for our works. I have lately seen some settings on the generator system with a sunk chamber of only 3 ft. 3 in.; the retorts being kept at a splendid heat with four-hour charges on a fuel consumption of 30 per cent. of the coke made.

At present I am building a new bench of three ovens, with six retorts in each, on the generator system. The sunk chambers are 5 feet deep. I should have been pleased if the work had been far enough advanced for you to have seen the plan of the flues, combustion chamber, &c.; but it is not so. I hope that at some future meeting I may be able to tell you of the results obtained by this setting.

One thing you will see at our works, which will be new to some of you, is a columnless spiral-guided gasholder on Gadd and Mason's principle. It is 60 feet in diameter by 20 feet deep, with a hydraulic cup for telescoping when required. It was erected in 1893. It rises and falls very steadily, even in the heaviest gales of wind. I have had no trouble with it, except once during the extra severe frost of the winter of 1894. The ice had frozen very hard on the water in the tank, and round about the inlet and outlet pipes. When the holder went down with the spiral motion it pulled the pipes with it; the joints at the ducks-foot bends gave way, and the pipes filled with water. I had to empty the tank, and get all set up again; but it has worked well ever since. Another thing which will be new to most of you is a Weck centre-valve for a set of four 12-feet square purifiers, with 12-inch connections, which I erected two years ago.

At present I am cutting out an old gasholder, and converting the tank into a tar and ammoniacal liquor tank, or rather into two tanks—one for tar and one for liquor. If any of you are contemplating doing anything in this way, you can see the plan on which I am doing mine, and it may be useful to you.

There has been a good deal of discussion lately about the standardizing of meter-unions; and I hope that there will be some practical result from it. Mr. Auchterlonie, of Mullingar, is to open a discussion on the subject; and I trust the result will be that the various meter makers will agree to make unions all to one pattern and pitch of thread.

Another thing I may mention, and I think that it would be as useful as the unions—viz., the standardizing of retorts. If this could be done, retort makers could always have a stock in hand, the same as they have of bricks. Then we should be saved the waiting, sometimes for several months, before our orders can be supplied.

And now, as you will be anxious to hear the papers read, I will not detain you any longer. I trust the meeting to-day will be for our mutual benefit.

Mr. E. Stears (Lisburn) proposed a hearty vote of thanks to the President for his address. He said it was very difficult to get anything new to say in an address to an Association like theirs; but he was sure Mr. Nisbet had acquitted himself to the satisfaction of everyone.

Mr. G. R. Love (Dundalk) said they had all listened with pleasure to the very interesting address they had had from the President. It was, perhaps, not full of elaborate phrases, nor yet of finely-turned points; but Mr. Nisbet had given them his own practical experience, which was backed up by a great deal of reserve power. He (Mr. Love) might just say, in passing, that in one point at least he thought the President had been napping, for neither generator nor regenerative furnaces had anything to do with inclined retorts. He had, however, much pleasure in seconding the vote of thanks to the President.

The President expressed his thanks for the kind remarks made.

Presentation of the Gold Medal.

The President said that the next item of business was the very interesting and pleasant one of presenting the first gold medal which had been won by any member of the Association. There was only one matter for regret in connection with the subject, and that was that there were no papers presented for competition this year. He hoped the presentation of the medal to Mr. Patrick Egan, of Tralee, for his paper on "A Difference in Hydraulic Mains," would be an incentive to other members, and that next year the Secretary would be inundated with papers. Addressing Mr. Egan, he said it gave him very great pleasure indeed, as President of the Association, to present him with the medal, which he hoped would be held in his family as an heirloom. He was glad, in a number of ways, that it was going to a member in the South, because he had always a great leaning to that quarter; and he trusted it would be the means of bringing members to the Association therefrom.

Mr. Egan thanked the President for his remarks, and the members of the Association for having decided to award the medal to him. He felt that it should have fallen into more worthy hands than his. He could assure them that it would be a source of great pleasure to him. He would treasure it as long as he lived, and would do so more especially because it was presented by an Association like the North of Ireland Association of Gas Managers.

[The medal was of chaste design, cruciform in shape, highly ornamented. It bore on one side the inscription: "Presented to Mr. Pat. Egan, Tralee, for a paper on 'Hydraulic Mains.' August, 1897;" and on the reverse side, the inscription: "North of Ireland Association of Gas Managers."]

Place of Next Meeting.

The Hon. Secretary said that, in Committee, Mr. Llewellyn had spoken, in the name of Mr. C. S. Spear, of Dublin, one of their extraordinary members, who was the proprietor of several gas-works in Ireland and the lessee of several Government gas-works, with regard to the place for their next meeting. Mr. Llewellyn and Mr. Auchterlonie had both the pleasure of working under Mr. Spear, who had sent a request by Mr. Llewellyn, that the Association might hold their meeting next year in some town with which he was connected; and that, if they did so, he would give them a hearty reception, and entertain them royally.

Mr. Llewellyn said the works with which Mr. Spear was connected, and which he authorized him to mention, were Mullingar and Athlone.

The Hon. Secretary said they had been talking of Dublin.

Mr. Llewellyn said that he had no authority to mention Dublin.

Mr. T. Hands (Enniskillen) thought they should go to Athlone.

Mr. R. Ross (Dungannon) seconded Mr. Hands' proposal.

Mr. Frizelle proposed Dublin; and the proposition was seconded by Mr. J. O'Grady (Mountmellick).

A show of hands was taken; and it was decided, by 19 votes to 10, to meet in Dublin.

The Gold Medal Competition.

The President asked whether the members thought they should offer a gold medal for competition next year.

Mr. A. Gibb (Newry) proposed that they should offer one for another year; and, in order to give the Hon. Secretary time to know what to do, they should make the date for sending in papers the 1st of May next.

Mr. Auchterlonie seconded the proposal; and it was agreed to.

Papers and Discussions.

Mr. R. Ross (Dungannon) read the first paper, entitled—

EXPERIENCE WITH PREPAYMENT METERS.

As some of the members may be contemplating the desirability of introducing prepayment gas-meters, perhaps I may be allowed to give my experience with them. In doing so, I would mention that, as far as it has been possible to obtain information, I claim to have as many—if not more—of these meters in use as there are in any works in Ireland. Up to date, I have over one hundred fixed, and more wanted.

We entertained the idea of introducing prepayment meters in the summer of 1896, and obtained samples from about five firms. We determined on using nothing less than 3-light meters. On testing them, we found there were only two firms whose meters we could depend on. Having decided as to the meters, we issued circulars among those whom we expected would respond; and we had applications coming in faster than we expected, or than we could attend to. In our circular, we proposed to put in a service, fix a meter, and put up one, two, or three brackets free of charge; the meter and fixtures remaining the property of the Company, and removable at any time.

We commenced about August to fix the meters; and before the end of the year we had about sixty at work. From March, 1897, to March, 1898, the gas consumed in these meters amounted to between 300,000 and 400,000 cubic feet. This is not a large quantity; but still it has increased our revenue.

In other places where prepayment meters have been introduced, they charge a small percentage over and above the price to ordinary consumers; but in our case we did not do so. Quite the reverse, as on calculating the gas to be supplied for a penny at the same amount as ordinary consumers paid, there was half a cubic foot over; and we gave this half foot to the consumers. Therefore the prepayment meter consumers have gas this much cheaper than the ordinary consumers.

The cost of fitting up the houses, including compo. pipe, brackets, fitters' time, and service, amounts, on an average, to about 30s., exclusive of meter. In kitchens or halls, we gave a strong wing or mantelpiece joint; and in bedrooms, a neat bronzed bracket, with gallery, but no globes. The smallest compo. pipe used is not less than ⅜-inch; and, unless asked for, we supply nothing larger than a No. 3 burner. The greater portion of the consumers have invested in an economizer, slipped over the burner. This certainly increases the light; but it does not reduce the consumption of gas.

At first, I had a lot of trouble with the consumers as to the number of hours the pennyworth of gas would last; and one party would say that theirs burned for 6 hours, another 6½, and so on. I was also told by some of the consumers that, unless they got a meter the same as so-and-so, which gave light for two hours longer than theirs, they would abandon prepayment meters. But I found there were two or three of the consumers who were circulating false reports as to the number of hours their meters gave light, in order to annoy those who were discontented; and on this being explained, the trouble ceased.

The pennyworth of gas lasts with a No. 3 burner about 4 hours; and with a No. 2 burner, 5 hours.

I had some trouble also with consumers owing to the fact that they would only put in one penny and allow the gas to burn out. Of course, as the valve closes gradually, they were thus, at the latter part of the time, with very little light. But I advised them to put in sixpence or a shilling in coppers; and showed them how to ascertain at any time how much gas was still due to them. Now each consumer knows what he burns weekly, and puts in the box as many coppers on a Saturday as will give him light during the week.

At first I was much troubled with crooked pennies; some nights as many as six of the consumers sending complaints that they had put in a penny, but that the handle would not turn, and they had no light. Of course, I had to go and get the pennies out; and sometimes this was rather troublesome. But the beaten-out penny is worse, as I had to uncouple the meter, turn it upside down, and insert the blade of a knife to get the coin out. However, the consumers are now getting more cautious, and examine the penny before putting it in the meter.

Another trouble I found was that in some of the meters the money-box was not tight up to the sides of the case, and one copper got jammed between the box and the case; another followed, and so on, until the mechanism became jammed, and the box had to be opened to relieve the coppers. But I splayed out the top of the boxes of those that thus troubled us, and made them fit tight to the side of the cases, and thus prevented the coppers jamming.

We have up to the present time removed the coppers quarterly; but in the quarters ending December and March, a good many of the boxes are full. I have got as much as 30s. from some of them; and there are a few where I have had to go and take out some coppers and replace with silver, as the pennies have no fall. I believe it would be better to remove the coppers monthly, at least in winter.

I was asked to call on one consumer, who informed me he had put in a half-crown by mistake, and the meter was stuck. I had to disconnect and turn the meter upside down before I could get the coin out. In two other instances, I got a two-shilling piece among the coppers. These had been put in by mistake for pennies; and of course I returned them.

Now that the consumers are getting used to the meters, and taking care about the crooked and beaten-out pennies, there is very little trouble with them; and we have a class of consumers who would not be secured in any other way. They appreciate gas, and not one has given up his supply. With the exception of two or three, they are all new consumers. These two or three were parties who were rather dilatory in paying their gas bills; and they requested to be provided with a prepayment meter. I asked why they wanted them; and they told me that in their case, when the quarter came round, they had some trouble in finding the money for the gas. But they would never miss a penny now and again with the prepayment meter; and when the quarter expired, the money was there in the box for the gas. It is really surprising the number of pennies that are obtained from some boxes, in the houses of the poorer classes. In some instances, they are rather astonished when the money is being counted out of the boxes.

I shall have some more of the meters to fix, as there are more applicants, but not to any great extent. All who have adopted the system are well pleased; and although it adds to the duties of the manager, and leads to him being called out at untimely hours—in some cases to unfix a crooked or beaten-out penny—he is thanked for his trouble. We have added somewhat to our consumption, and are well pleased with the results.

We find no trouble in disposing of the coppers, as between the mill, the factory, and the bank we get quit of them all. But £34 of coppers is no joke to get removed from the boxes, counted, and put away in separate lots. It takes time, and involves some trouble.

Since writing the above, I have seen that at the meeting of the North British Association of Gas Managers, held on July 28 [*ante*, p. 205], Mr. Andrew Wilson, of Perth, said there were 1100 penny-in-the-slot meters in working-class houses and lodging-houses in Perth, and that these meters gave the best pecuniary return. Mr. Ballantyne, of Rothesay, said this type of meter had a great future before it; and Mr. T. Wilson, of Coatbridge, said there were 1400 of these meters in use in his town, and that they now gave 28 cubic feet of gas for 1d. Very few of us, at least in inland towns, can give that amount of gas for the penny; but in Coatbridge they can well afford to do so, as I saw not very long ago that they can get coal laid inside the works at 6s. 6d. per ton. Some of us pay that amount per ton as freight from Belfast. The meter is seemingly going ahead in Scotland, as I also see that they are going to introduce it in Paisley. But think of the enormous number of these meters in use belonging to the great London Gas Companies—the Gaslight and Coke Company with 90,000, and the South

Metropolitan Company with 72,000, and to each of which is attached a small gas-cooker. At one collection they lift over 12 tons of coppers in lorries.

Discussion.

The PRESIDENT said they had heard Mr. Ross's statement as to how he had succeeded with penny-in-the-slot meters. If any gentlemen present were contemplating introducing them, he was sure Mr. Ross would give them any information he could. He (the President) himself had a few of the meters in Portadown; though not so many as Mr. Ross—he wished he had. However, he had somewhere about forty; and he found that the people were very well pleased with them. They gave a little more trouble than other meters, but they paid.

Mr. T. HANDS (Enniskillen) asked the number of feet of gas Mr. Ross gave for 1d., and the cost of putting the meters in.

Mr. ROSS: About 30s. each.

Mr. HANDS said he had tried every maker's meter, and had a number of prepayment meters giving satisfaction. He remembered putting one in for a shoemaker, who would say to his customers: "Just put a penny in this slot, and you will see a bird come up and sing." A good many pennies were got by him in this way, and so he had his gas for nothing. He (Mr. Hands) had had a great deal of trouble with the meters; but he now thought that they were the backbone of the gas industry. The money was in them, and they secured consumers whom they could not get before, because they had not the money wherewith to pay a quarter's bill.

Mr. G. R. LOVE (Dundalk) remarked that Mr. Ross was much more go-ahead than he would be. He found that he had about a hundred meters fixed, and that he supplied compo. pipe, bracket, time, &c., at a cost of something like 30s. each. The Company Mr. Ross represented spent about £150 of capital upon these meters for the sake of getting a few additional consumers. This might be of little consequence where the population was settled; but if they had a shifty population, it would be a considerable loss, because they might have to remove the brackets. Mr. Ross pointed out that these consumers actually got half a cubic foot of gas more than consumers with ordinary meters. This was an unusual thing, because nearly all gas companies charged something extra to prepayment meter consumers. He thought Mr. Ross's Company were dealing exceptionally liberally with these consumers; and he did not think anything that was supplied in this way for nothing was appreciated so much as it would be if they charged a little for it. He did not consider that he should go so far as Mr. Ross in this respect. Like Mr. Hands, he should be glad to know the quantity of gas Mr. Ross gave for 1d. As for his troubles, these also added to his expenses. He had more collections; he had the coppers to take up, which he had not with ordinary meters; and he had the coppers to dispose of. This entailed a good deal of trouble and expense beyond the £150. He thought it was an unprofitable thing to go on the lines laid down by Mr. Ross; and he (Mr. Love) certainly should not like to submit such a scheme to his Directors.

Mr. T. FRIZELLE (Holywood) said Mr. Ross's experience had been a very instructive and interesting one. Anything which tended to increase the consumption of gas would be hailed by every gas manager. The prepayment meter had been a great boon to them, as well as to consumers who were not in a position to pay quarterly accounts. In the first place, it removed the cause of accident in the matter of oil lighting, which had led to many deaths; and it furnished a light on easy terms. The Company he had the honour to serve introduced prepayment meters about twelve months ago. They also held an exhibition of gas-stoves. The result had been very satisfactory. They had eighty slot meters in use; and almost all the consumers who used them were new, having been previously oil burners. The consumption of gas with each of these meters had been about 7000 cubic feet, and they had not been working for a full year. The price was the same as that charged to consumers through ordinary meters. They gave 20 cubic feet of gas for 1d. His Directors paid for the brackets, as well as the service-pipes put into all houses the valuation of which did not exceed £8. He could assure the members that these meters were the means of bringing gas within the reach of consumers they would not otherwise have. They, as managers, liked augmented consumption; and so did their Directors, for the reason that the profits were increased, which was a sign of progress. From the 80 meters he (Mr. Frizelle) had, they had lifted £110 5s. Mr. Ross did not lift so much with his. He had no reason to regret putting in prepayment meters; and his Company were recovering any expenses they incurred in connection with them.

The HON. SECRETARY said he felt the members were very deeply indebted to Mr. Ross for bringing the subject of prepayment meters before the Association. He would very much like some of those who had not had experience with prepayment meters to ask questions of Mr. Ross, because he was sure they had been thinking about these meters, and there might have been difficulties in the way which prevented their adopting them, and things might have occurred to them which Mr. Ross, or some others who had had experience, might be able to clear away. His own experience agreed to a large extent with that of Mr. Ross, though he had not pushed the thing as that gentleman had done. He had had too much to do, for one thing; and for another, he had often been uncertain in regard to the policy, which had been disputed, of fitting up houses for prepayment consumers. He had not attempted anything of the sort. He treated these consumers just as he treated ordinary ones. The Company put in the service-pipe through the wall, and supplied them with a slot meter. The people themselves connected this with the service, and laid what pipes and fittings they wanted, and had the gas at the same price as the other consumers—22½ cubic feet for 1d. They had experienced some of the troubles about which Mr. Ross had spoken. The crooked penny was an awful nuisance. Sometimes he had to send a meter back to the maker because he could not get the penny out. He had never found a paper disc in a prepayment meter; but he had had soda-water capsules beaten out. The finding of one of these things led to a row or a threat that the meter would be taken away. A prepayment meter was not in the same position as an automatic machine at a railway station, because, in the case of the meter, they knew who put in the bad coin. He had only about 45 penny-in-the-slot meters in use; and the average return from them was 30s. or 32s. a year. Last year, he had £78 out of 44 meters. He found that the average number of these meters in use kept about the same. After they had had a customer for some time with a slot meter, and found he was doing right, they occasionally gave him an ordinary meter; but then somebody else would possibly be applying for a slot meter. People did not go to the expense of fitting up their houses for the use of gas without having made up their minds to burn it; and when once they had incurred the expense, they would think twice before they gave it up. In getting a number of new consumers, they had not to look at the £150 they expended to secure them, but to the million or so cubic feet more gas which they would sell in a year. Beyond this, there were staff expenses which did not increase with the quantity of gas produced. The cost of the extra gas made was little more than the price of the coal. They could therefore well afford to supply the gas cheaper even in the first instance, because they were bringing in a new set of customers. He thought there were two ways of looking at this question. While

Mr. Love might be very clear in his opinion, there was plenty to be said on Mr. Ross's side too; and he believed that if the latter gentleman found it pay him, he would not care very much what others might say.

Mr. E. Stears (Lisburn) said he had found it to be a very great drawback that he could not furnish a supply of gas without a deposit; but prepayment meters obviated this. He supplied 20 cubic feet for 1d., and sold gas by ordinary meters at 3s. 6d. per 1000 cubic feet, which was practically the same. But the great advantage of the prepayment system was that, if there were fittings in the house, the consumer had a slot meter put in free. He did not go past the meter. These meters gave him no trouble. One or two pennies might stick; but this was only a trifling matter.

Mr. Love said he forgot to mention that he had a great number of prepayment meters attached to cooking-stoves, in the use of which they were a great help. He supplied gas for cooking, heating, and motive power at 7½d. per 1000 cubic feet less than for lighting; and he had separate services.

Mr. A. Gibb (Newry) thought prepayment meters were very useful adjuncts to gas-works. By them a manager could get at a class of consumers who never could be reached otherwise. As had already been said, there was a difficulty in getting 5s., 10s., or 15s. at the end of a quarter; but they could obtain far more than this by the prepayment meter. People were in the habit of buying a pennyworth of oil, and never thought of the penny—it was the come-at-ableness of the thing they thought of; it was not so with 5s. or 10s. But people dropped a penny into a prepayment meter now and again, and the consequence was that, in small greengrocery and such-like establishments, they would now go in for a very large supply, and by this means they considerably increased their consumption. He had only had prepayment meters for two years and a half; and he had never canvassed anybody to take them in. The first half year he sold 47,409 cubic feet by two or three of them; the next year it was 121,767 cubic feet; and last year, with 32 meters, he sold 185,395 cubic feet. So that they were going quietly along, and were substantially increasing their consumption. Moreover, they were not asking anyone for a deposit. They connected the meters, and the consumers did all the inside fitting themselves. He thought that if gas managers were to try to cultivate the introduction of penny-in-the-slot meters, they would find that they would lead to a large additional consumption of gas. He had, on two occasions, found a two-shilling piece instead of a penny

He had very great satisfaction in testifying to the worth of the paper Mr. Ross had brought before them.

Mr. Stears mentioned that the man he sent out to collect the money took with him for every meter a bag into which he put the money, and did not count it before the consumer. He thought this was a very good plan, because they might think they were consuming too much gas if they saw how much money there was.

The Hon. Secretary, Mr. Gibb, the President, and Mr. Hands remarked that this was their plan.

Mr. Ross, in reply, said Mr. Love complained about giving half a cubic foot of gas by way of abatement; but his object was to increase his consumption. About six tenants who had prepayment meters in his place had shifted; and the houses they left had been more readily taken because the gas-fittings were all in. He did not charge meter-rents, for either prepayment or ordinary meters. He gave 15 cubic feet of gas for 1d., which came out at about 5s. 6d. per 1000 cubic feet. It was a point in his favour that in some houses, where they would not give perhaps 10s. for all that was in the place, they might now get 15s. for gas. He was perfectly satisfied. He had increased his consumption, and expected to increase it more. He had one cooker attached to a prepayment meter, and possibly by next year he might be able to tell them something about the application of prepayment meters to cookers.

The President expressed his pleasure at the interesting discussion they had had. He pointed out that one thing which they had all forgotten to mention was that if they had a consumer using an ordinary meter, and had any difficulty in getting money from him, they could simply put in a prepayment meter, and then they would get their money down. He gave 20 cubic feet of gas for 1d. It should really be 22 feet; but the meters cost a good deal more, and they had to charge accordingly.

Mr. A. Gibb (Newry) read the following paper:—

THE WORKMEN'S COMPENSATION ACT, 1897.

The 1st of July, 1898, will be long remembered by those who are engaged in the manufacturing and mechanical industries of the three kingdoms as the day on which the Workmen's Compensation Act of 1897 came into operation. Its framers cannot be blamed for loquacity or want of incision in every detail of the measure. It has only ten sections, with their sub-divisions;

and, leaving out the two schedules, it occupies only six pages. Yet within this small compass great issues are comprised. How the Act will operate on the various industries of this country is a subject of pure speculation. If employer and employed work in friendly agreement, much heart-burning and jealousy will be avoided, and freedom of action will ensue; and the sound of the hammer and the shuttle, and the roar of steam, will make glad the inhabitants of the land. In introducing this subject to your notice, my object is to elicit your opinions upon this important measure, the scope of which I will briefly indicate.

Section 1 states that compensation must be given for any accident causing personal injury, if of more than two weeks' duration. The only disallowance that can be claimed by the employer is where "*serious and wilful misconduct*" on the part of the workman can be substantiated. But here a difficulty arises. What constitutes an accident? And what is contributory misconduct? Sir R. T. Reid, Q.C., M.P., in the case of the Lancashire and Cheshire and North Wales Miners' Relief Societies, defines an accident as "an occurrence out of the ordinary which produces death or disablement from work." There must be some casualty or special occurrence. Death or disablement not produced by a particular occurrence to which one can point, is not a case of "accident" within the rules that have been framed under the Act. And even if a particular occurrence can be indicated as a cause, there is no accident if it is "something which comes in the ordinary course in the work the man undertakes." In most cases, an "accident" is accompanied by something in the nature of violence—a fall, a blow, or an explosion. However nicely one may adjust the definition of the word "accident," there will always be cases on the borderland.

Sub-section 2 (*c*) sets forth that if it is proved that the injury to a workman is attributable to the "serious and wilful misconduct of that workman," any compensation claimed in respect of the injury is to be disallowed. This sub-section will form the framework of all litigation under the Act, as the difficulty will be to define "serious and wilful misconduct."

Section 2 specifies the time of notice, and explains how one is to proceed in different cases. There is a limit to the time of recovery under the Act. Notice is to be given as soon as practicable, and before the workman voluntarily leaves his employment; and the claim for compensation must be made *within* six months—in the case of death six months from the time of death. "Months" here means calendar months.

Section 3 indicates the duties of registrarship. Where the employer wishes to contract out of the Act, the scheme is to be laid before the Registrar of Friendly Societies for his approval or rejection, according as the terms are better or worse than the provision of the Act. While the Bill was passing through the House, great stress was laid upon a scheme of mutual agreement between the employer and the workmen.

Section 4 deals with sub-contracting, where the undertaker becomes liable for all accidents. It is enacted by sub-section 3 that the section "shall not apply to any contract with any person for the execution by or under such contractor of any work which is merely ancillary or incidental to, and is no part of, or process in, the trade or business carried on by such undertakers respectively"—to wit, the erection of gasholders or any other appliances connected with gas making.

Section 5 stipulates that compensation to a workman is not to be affected by bankruptcy, but is to be a first charge on the estate.

Section 6 provides that, in cases where legal liability may rest on some other person than the employer, the workman may elect to proceed against that person; but two actions cannot be taken on the one case. If the employer should have to pay compensation under the Act, he is to be entitled to indemnification by the other party.

Section 7 sets forth the employments to which this Act applies; gas-works being included in the section.

Section 8 exonerates persons engaged in the naval or military service of the Crown.

Section 9 declares contracting out of compensation existing at the commencement of the Act to be void.

Section 10 specifies that the Act may be cited as the Workmen's Compensation Act, 1897.

The foregoing is a bare outline of this important Act. Why the conductors of gas-works, with which we are immediately concerned, should be called upon to pay the increased rates of insurance for their workpeople demanded by the various Insurance Companies is a puzzle to me. If we take the accidents which have happened in connection with gas-works, and compare them with other industries, there is a very clean sheet presented on their behalf. Of course, the Insurance Companies wish to protect themselves; and they are perfectly right in so doing. But their demands at the present time are exorbitant, and out of proportion to the risk; some of them quoting 25s., and others different rates down to 7s. 6d. per £100 of wages paid.

Those of you who read the technical papers will have seen the various insurance plans proposed; and therefore I need not take up your time in dealing with them. Mr. Chamberlain says the object to be attained by the first clause of section 3, where reference to registrarship is introduced, is that "we do not wish to prevent a workman doing better for himself, by the consent and with the goodwill of his employer, than legislation can do for him." If you will refer to Vol. LXXI., p. 1328, of the *Journal of Gas Lighting*, you will find the report on the first six months' working of the accident fund of the South Metropolitan Gas Company, where full details are given. I have no doubt that, after the Act has been in operation a year or two, Insurance Companies will have obtained data to enable them to reconsider and greatly reduce their present high charges.

And now, in conclusion, I have only to express the hope that it may be a long time ere the company or the corporation of any gas manager will be brought within the grip of the Workmen's Compensation Act of 1897.

Discussion.

The PRESIDENT said that none of them had had any experience of the Workmen's Compensation Act; and it was to be hoped it would be a long time before they had. Had the members anything to say upon it.

Mr. G. R. LOVE (Dundalk) was sure they were all indebted to Mr. Gibb for bringing the subject before them, as it was one which interested every gas manager. He had no doubt but that a great many of them had been thinking over the question—they had been forced to do so, owing to their position under the new Act. Previous to the last meeting of The Gas Institute, his Directors had been considering the matter; and they had asked him to keep his ears open, in order that he might be able to give them guidance upon it. The discussion which took place at The Gas Institute meeting, upon the paper by Mr. Ellery, to his mind, fully opened up the subject. It gave him one or two good hints in the matter. One gentleman—he forgot his name—advised them not to insure under the whole Act, and said he considered that if they covered themselves against risk from fatal accidents only, for twelve months, by that time the Insurance Companies would have settled down, and it would be better known what the amount of their charges should be. After he got home, he turned up the file of the *Journal of Gas Lighting;* and he had made a list of all the accidents reported there for the year 1892. He found that the number of deaths which occurred during the twelve months from accidents in gas-works that were reported was 18; the number of serious injuries was 8; and of only slight injuries 10. He could give the details, if they were asked for. Considering the number of men employed in gas-works, this was a very short list; and the gentleman who advised them to cover against deaths only, gave them good advice. He therefore recommended his Directors to insure only against fatal accidents. They effected an insurance of this sort for a premium of 5s. per £100 of wages paid. Down till this year, they had been insured under the Employers' Liability Act and at common law, at a cost of 2s. per £100 of wages. His Directors thought it would be a wise thing to continue the old policy; and so they were now insured under all forms of liability. He had been seven years in Dundalk; and he had never had an accident of any kind. He supposed that nearly everyone present could say the same of accidents. He had asked himself why it was that the Insurance Companies were seeking such a high premium as 25s. per cent. Some Companies reduced this to 12s. per cent.; but they reserved certain things which might have made almost inoperative any policy at that rate.

Mr. T. HANDS (Enniskillen) said that it might be well for them to ascertain, first, whether the Act applied to them. He believed that men who were employed laying mains, and the like, did not come under the Act. He had been seven years in Enniskillen, and had had no accident; though, of course, he could not say how soon he might have one. But why should they be compelled to pay exorbitant rates? Owners of gas-works should combine, and should set aside a small percentage upon the wages they paid; thereby letting the Insurance Companies see that they could do without them. He believed then that in a few months the rates would be reduced, and they would be able to insure their workmen without paying unreasonable rates.

The HON. SECRETARY said that Mr. Hands had just struck the question which was present in his mind. It was, he thought, highly important that they should have some information upon this; and he had been waiting for the meeting to see if any would be forthcoming. The Act said that whatever works it applied to must be works where steam, water, or other mechanical power was used. He could understand, with reference to large gas-works, where mechanical power was used for the handling of coal, coke, and the like, that they should come under the Act. But there were many small gas-works, in which there was no mechanical power, not even an exhauster; and the question was whether these were not entirely outside the Act.

Then there were gas-works in which the exhauster was often standing idle during the summer. Would these works be within the Act when the exhauster was working, and outside its operation when it was idle? It was a question whether they were, or were not, within the limits of the Act. The position of his works was such that they suffered severely in storms. Almost every storm damaged their roofs. If a slate were to fall upon a man and hurt him, what would that have to do with mechanical power? and why should it bring them within the limits of an Act of Parliament like the one in question? It was quite right that they should pay for the protection of their workmen; but it seemed to him to be hard that they should be called upon to pay such an exorbitant sum as the Act stipulated. It said that they should pay nothing less than £150, or three years' wages, when they went over that. The accidents at his works were very trifling. He had been fifteen years at Armagh, and he had never had an accident which would come under the Act. Before he sat down, he wished to remind them of the communication from the North of England Gas Managers' Association. They might pass a resolution upon this communication; and he thought they could not do better than work in harmony with other Associations.

Mr. P. Hurll (Glasgow) said that this was a subject which had given the people in his trade a great deal of trouble. The wages which they paid amounted to about £16,000 a year. They commenced to make inquiries as to what the rates of insurance on this sum would be; and they found that it would be 30s., or at least 25s., per cent. They discovered that there was a combination among some Insurance Companies. They held out for a little, and found that there were some other Companies, outside the ring, who were trying to secure the business at much lower rates. At a meeting of the trade which was held, they considered whether they should not join together and run a small Mutual Insurance Company. Then they had an offer from a firm of accountants in Glasgow, offering a rate of only 10s. per cent. They held another meeting, which was attended by eight or ten firms, paying a good round sum of wages; and they said "No; we will form a mutual society rather than pay these rates." So the matter was really left in his hands, to do the best he could for the whole of the firms in the trade. He thereupon obtained a quotation of 7s. per cent. for all their above-ground workers, and of 9s. per cent. for below-ground workers. They considered these very moderate rates indeed; and they at once closed for about eight or ten different concerns, on these terms. Their previous rates were about 3s. 6d. per cent.; so that they were now about double what they previously paid. It was the Ocean Insurance Company they insured with; and the accountants who were acting for them said it was only experimental, and that possibly at the end of the year the rates would be reconsidered, perhaps reduced. He did not think that because in gas-works mechanical power was not employed, their owners were relieved of responsibility. If they considered the case of a quarry, where there might be no mechanical power, but where the stone was being carried out in a hand-barrow, the owner was liable.

The HON. SECRETARY: But a quarry is specifically mentioned in the Act.

Mr. HURLL said if they took the case of a builder, if a scaffold gave way, and a man fell with it, the builder would be liable. He thought that, if gas-works owners were depending on getting clear of any claims under the Act, on the ground that they had no machinery, they would find they were making a mistake.

Mr. J. W. AUCHTERLONIE (Mullingar) said he believed that the only occupations left out would be agricultural labourers, seamen, workshop workers, and builders on buildings under 30 feet high. He approved of the mutual insurance system, because, if premiums were found to be too high, they would be reduced next year. He thought they, as an Association, certainly ought to support the North of England Association. He moved that they support the idea of mutual insurance, unless they were offered more favourable terms from Insurance Companies.

Mr. T. FRIZELLE (Holywood) supposed that, as managers of gas-works, they had no authority, as delegates to the Association, to speak for the owners of the works. The Company he represented had insured at 12s. 6d. per £100 of wages. They thought it was better to do this in the meantime, and to see how the Act would work.

Mr. T. LLEWELLYN (Newbridge) thought that the question of gas-works proprietors coming within the operation of the Act or otherwise, was one which was a little beyond their debating powers, as gas managers. It was purely a legal question, which would have to be fought out in a Court of Law, if an accident occurred in their works. Then they would probably learn, with some practical and unpleasant results, that gas undertakings were liable for any injury which might be sustained by the men in the works. Personally they were not much interested in this responsibility, because they were servants of the gas company, and not proprietors of the works; but really, he thought, it would be an erroneous idea to go forth from the meeting, that they considered there was no liability for injuries in gas-works, or that they had no cause to regard the Act as binding upon them.

Mr. LOVE said he was not certain, from memory; but he thought that at The Gas Institute meeting it was stated that legal opinion had been obtained, to the effect that they were under the Act.

Mr. S. B. LANGLANDS (Coleraine) said that immediately after he learnt what The Gas Institute had to say in the matter, he brought the subject before his Committee; and they thought it wise to insure. They had done so, at the rate of 20s. per £100. They obtained Counsel's opinion in the matter, and were advised that they were liable, under the Act, for any person on the works—even the employee of a sub-contractor.

Mr. LOVE suggested that, as they had not any authority from their companies, they should, in the meantime, thank the North of England Association for their communication, and inform them that, while they had discussed the subject, they were not at present in a position to come to any decision upon it.

This was agreed to.

Mr. GIBB, in closing the discussion, said he had made an effort to explain and define the penal wording of section 1. Compensation for injury sustained by a workman might be viewed under three heads—first, as it stood in common law; secondly, as the Employers' Liability Act of 1880 affected the common law rights (43 & 44 Vict., cap. 42); and, thirdly, as it stood on a new basis by the Workmen's Compensation Act, 1897. Legislation had been progressive since the reign of George III. The Mines Regulation Act, 1872, the Factory Act, 1878, and the Employers' Liability Act, 1880, culminated in the Workmen's Compensation Act, 1897. The Act of 1880 implied more generous treatment and conditions of employment; while the Act of 1897 *compelled* their adoption, and imposed new duties and obligations on the employer. "Personal injury" meant physical injury to person, and also injuries to the health. But, surely, where disease was caused by the action of a known natural agent, it could not give rise to compensation. The word "accident" had already been defined. Mr. Thomas Bevan, B.L., afforded another as follows: "An occurrence which could not have been avoided by the use of the kind and degree of care necessary to the exigency, and in the consequence." He also gave two specific tests applicable in ascertaining whether an occurrence was an "accident" or not: "Was the result contemplated?" and, if so, "Was the result the ordinary and natural sequence of the course of action preceding it?" If an "accident" arose out of the employment, or occurred while the workman was engaged in it, he was entitled to compensation under the Act, even though it was found to be due to the misconduct of a stranger. Section 6 regulated this right of the workman. The converse of this, surely, ought to be equally applicable, and should constitute a "wilful" act. If the stranger or fellow-worker took the occasion of the workman being engaged in the employer's work to injure him by a wilful act, though the injury should happen while the workman was engaged in the employment, the injury would not "arise out of" or be "in the course of" the employment. The civil liability of the employer was either at common law or under the Employers' Liability Act, 1880. As to "serious and wilful misconduct," contributory negligence could not be set forth as a defence. "Wilful" meant that the person knew what he was doing, intended to do what he was doing, and was a free agent. "Serious" had not yet been defined or decided by any tribunal; but, in plain terms, it signified that which was grave, weighty, earnest, and important, in opposition to what was trifling and unimportant. Serious misconduct demanded attention, and could not be passed over. That which constituted serious and wilful misconduct was a subject of grave importance, and rested to a great extent for the Arbitrator. (See Second Schedule, Provision 4.) The Secretary of State might appoint legally qualified medical practitioners, so that any workman receiving weekly compensation must, if desired, submit himself for examination to the medical practitioner. Should he refuse, the compensation would cease till such examination had taken place. (See First Schedule, Rules 11 and 12.)

STANDARDIZING METER-UNIONS.

Mr. J. AUCHTERLONIE (Mullingar) read a paper on "The Standardizing of Meter-Unions," which contained the following passages: In the month of February last our Association (in common with kindred institutions throughout the United Kingdom) was asked by the North British Association of Gas Managers to co-operate in the standardizing of meter-unions. Our Committee unanimously approved of the proposal; and this being our first meeting since the receipt of the communication, I have been asked to introduce the subject for your consideration. But really so much has been said in favour of the proposed standard connections, and so little against them, that it would be almost useless for me to reiterate what has already been advanced by all grades of gas managers. . . . Those of you who were at The Gas Institute meeting will remember that the proposal was very favourably received, and ultimately left to the Council of the Institute to deal with. I have not much more to say, except that personally I approve very strongly of the proposed standard unions. It has been one of the many inconveniences that gas managers have to contend with, especially managers of small gas-works. Another matter which ought to be taken in hand is the reduction of the infinite variety of retorts that are in use. Meantime, our thanks are due to Mr. Myers and to the North British Association for what they have done in the matter; and I think that we to-day may safely agree to leave the matter with the Council of The Gas Institute, and heartily support them in carrying the object to a satisfactory termination.

Discussion.

The President said this was a very important subject. It would save them a good deal of trouble and annoyance in changing meters, if they had standard sizes for the unions. He thought it was a matter which might be very easily settled. If the various Gas Associations could make up their minds to agree upon what they wanted, he believed the meter makers would give them meters all with similar couplings.

The Hon. Secretary said he thought it was of great importance that they should have all gas-meter unions of the same size, especially where they had no gasfitters in their employment, because they would then be able themselves to remove a meter and put on one by another maker.

The President thought that if the matter were in the hands of The Gas Institute, and they intended to take some definite action, their Association should adopt a resolution which would strengthen the hands of the Institute. They should, he thought, fall in line with the others, and support them in the matter.

Mr. G. Cummings (Ballymoney) said that, like all subjects, this required to be looked at from both sides. It would do good in one way, but it might not in another. He had himself rather than take out a coupling, altered the meter to suit it; and he had found this to be as useful as altering the coupling.

Mr. T. Llewellyn (Newbridge) thought that while they were agreeing to fall in with the standard unions for meters, it would be well that it should go forth from them, as an Association, that they would prefer to have longer linings for the larger sizes. Of course, they all were agreed on the principal idea—of having the same sized couplings, so that the meters might be interchangeable; but he believed that a little suggestion, such as he had proposed, would not be out of place.

Mr. S. B. LANGLANDS (Coleraine) said he had much pleasure in moving that they, as the North of Ireland Association of Gas Managers, express their gratification at The Gas Institute having taken up the subject of standard unions for gas-meters, and that they agree to support them in it; adding Mr. Llewellyn's suggestion as a rider.

Mr. A. MACKENZIE (Edinburgh) said they would find that, if they went in for finality, the meter makers would be pleased to do what they wanted.

Mr. A. GIBB (Newry), in seconding Mr. Langlands' motion, said that there had been discussions about going to the Board of Trade on the subject. He thought it was a matter which was altogether outside the jurisdiction of that Board, who had only to deal with capacity to measure. If the various Associations were pleased, the meter makers could adopt the uniform set of unions; and this would facilitate matters very much. He thought, also, that they should thank Mr. Auchterlonie for having laid the matter before them.

The motion was adopted; and Mr. AUCHTERLONIE returned thanks.

THE LUNCHEON.

At the conclusion of the discussion on the first paper, the members adjourned to the Town Hall, where they were entertained to an excellent luncheon by the Directors of the Portadown Gas Company. Mr. A. Thornton, the Chairman, presided, and, on behalf of the Company and the community of Portadown, gave the Association a very hearty welcome, and thanked them for their visit to the town.

VOTE OF THANKS TO THE PRESIDENT.

The HON. SECRETARY, at the conclusion of the proceedings, proposed a hearty vote of thanks to the President, for his conduct in the chair.

The PRESIDENT thanked the members for their kind expression and vote. He said he was willing to do anything he could for the Association at any time. One thing he was sorry for, and that was that they had not had the presence of Professor Ivison Macadam. It was a great loss to them that they had not heard his lecture. There was still on the *agenda* another paper, by

Mr. Fitzsimmons, which they had not been able to take up for want of time.

This concluded the proceedings.

EXCURSION TO LOUGH ERNE.

The following day, the members of the Association and lady friends travelled by rail from Portadown to Enniskillen, where they became the guests of Mr. D. D. Macpherson, of Manchester, one of the extraordinary members of the Association. A hurried visit was paid to the Enniskillen Gas Company's works, where they saw some of the astonishing appliances which the Manager (Mr. T. Hands) employs in the production of gas. They then joined the steam yacht *Widgeon*, which, by the way, was built, or rather rebuilt, by Mr. Hands, and made a remarkably comfortable boat. Upon it the party were conveyed, amid the varied beauties of the incomparable Irish Lough Erne, to Little Paris Island—one of the gems of the loch—which is owned by Mr. Hands, and which was being occupied by Mr. Macpherson for the purpose of a holiday resort. Mr. and Mrs. Macpherson gave their visitors a hearty reception, and treated them right royally in a spacious and beautifully decorated banqueting hall on the island. Dinner over and a cordial vote of thanks having been accorded to their host and hostess for their hospitality, a cruise of an hour's duration was enjoyed among the islands in the neighbourhood. A return visit was paid to Little Paris Island, where a hasty tea was served. The party returned by the yacht to Enniskillen; Mr. and Mrs. Macpherson travelling with them, and seeing them off by train.

MANCHESTER INSTITUTION.

QUARTERLY MEETING, AUG. 27.

On the occasion of the One-Hundred-and-Fifteenth Meeting of this Institution, the members—by invitation of the Gas Committee of the Warrington Corporation, conveyed through the President (Mr. W. S. Haddock), who is their Gas Engineer—journeyed to Warrington for the purpose of inspecting the Longford Gas-Works. There was a fair number of members to be received by Mr. Haddock while partaking of the light refreshments thoughtfully provided for the party on reaching the works. After this, an hour and more was occupied in a thorough examination of the plant designed, and to a large extent completed, by the Corporation's late Gas Engineer, Mr. James Paterson, and in course of being considerably modified and extended by Mr. Haddock.

A succinct account of the works had been prepared by Mr. Haddock, and was handed to the members. It seems the works date from 1820; having been built in that year by Messrs. Barlow Bros., who had the management entirely in their hands until the cost of construction had been paid off. The town was first lighted with gas in 1821; and the price then charged for it was 15s. per 1000 cubic feet. The first record available as to the annual make of gas shows that in 1839—the price being then still as high as 15s. per 1000 cubic feet—the make was between 13 and 14 million cubic feet; and eight years later (in 1847, the year when the original Gas-Works Clauses Act was passed) the make had only increased by about 3 millions, though the price had been brought down to the then low rate of 4s. 6d. per 1000 cubic feet. The purchase of the works took place in 1877, by which time the make of gas had increased to 128 millions, and the price had been reduced to 3s. 3d.; while now the make is 282 millions and the price 2s. 10d. The original works were constructed on what was known as the Mersey Street site; and this was only given up in 1897 as a manufacturing station. It had meanwhile been rebuilt several times; but in 1879, as it had become necessary to make further extensions, the Corporation were compelled to select a new site. This was found at

Longford; and 16 acres of land were purchased. A siding from the London and North-Western Railway Company was brought on to the land; and by this the coal-trucks are run alongside the retort-house on an elevated railway—the coal sliding out of the trucks, by releasing the trap-doors, into the coal-store. At the time of the visit, alterations were being made in the retort-house, which is 74 feet wide and 190 feet long. The retort-settings comprise two benches, each containing six beds of eight D retorts, 22 in. by 16 in. The settings are on the Klönne system, as modified by Mr. R. O. Paterson, of Cheltenham. They are capable of producing rather over 1½ million cubic feet of gas per day. The retort-house is arranged for West's manual stoking machinery; and each setting is provided with a separate hydraulic main, so that any one section can be closed off at will. It is intended to pull down the old retort-benches, and double the new arrangement. The condenser is vertical, consisting of four rows of 12-inch cast-iron pipes. Each row contains fourteen lengths of pipe, about 30 feet high. The exhausters are of Messrs. Donkin and Co.'s manufacture, and comprise two 40,000 cubic feet drums driven by a separate engine, and two 60,000 cubic feet drums and engine combined. The tar washer is by Messrs. C. & W. Walker, and is designed to remove the tar when passing 2 million cubic feet of gas per day. There are two scrubbers, each capable of purifying 500,000 cubic feet of gas per day. The tower scrubber is 90 ft. by 9 ft., and was made by Messrs. Ashmore, Benson, Pease, and Co. It is fitted with Green's patent screens and water distributor, and is used for the purpose of concentrating the weak liquor from the other washers. The washer-scrubbers are of the Kirkham, Hulett, and Chandler "Standard" and the Clapham "Eclipse" makes. The purification of the gas is finished in six boxes, 47 ft. 3 in. by 20 ft., made out of two 20-feet square boxes. As then working, one box was arranged as a catch purifier. The material for charging the boxes is lifted by chain-elevators from the ground floor, and deposited into barrows in the boxes, and so spread over the grids. Each purifier has four 16-inch shoots, through which the foul material is discharged on to the ground floor. The covers are raised by a winch, driven by belting from a steam-engine. The station meter is one of Messrs. J. & J. Braddock's manufacture, and is capable of passing 70,000 cubic feet of gas per hour. The two holders are telescopic; and when filled they contain about 1½ million cubic feet of gas. There are also three small holders at Mersey Street, which contain ½ million cubic feet of gas when filled. They are supplied with gas from the Longford works; a special main and exhauster plant having been put down solely for this purpose. The gas is distributed from Longford through one 20-inch and one 16-inch governor, both of Messrs. Braddock's manufacture. At Mersey Street, there are two 12-inch governors and one 16-inch. The sulphate plant consists of one of Messrs. C. & W. Walker's continuous stills and heaters, capable of working up from 25 to 30 tons of liquor per day. The saturator is designed for a Wilton discharger, by which all the salt is raised on to the draining-floor. The tar plant at the works consists of a primary still for working 10 tons of green tar. The vapours from the primary still pass through one of Ellison's patent heaters, by which the green tar is heated, and to a certain extent dehydrated. The cistern for storing the oils is arranged to act as the roof of the press-room and anthracene store. Much interest was evinced in the working of a Wells pneumatic painter in operation in the purifier-house.

The members soon after midday were driven to the Lion Hotel, and there entertained to lunch by the Gas Committee. The chair was occupied by Mr. Alderman Fairclough, J.P., the Deputy-Mayor, and Chairman of the Gas Committee; the vice-chairs, by Mr. R. Heaton, the Deputy-Chairman of the Gas Committee, and Mr. John Evans. At the conclusion of the luncheon, a few toasts were honoured; and then Mr. W. R. Chester proposed, and Mr. R. G. Shadbolt seconded, a hearty vote of thanks to the Corporation Gas Committee for their hospitality during the day.

At 2.30 conveyances started to take the members and a few friends to Knutsford, *viâ* Arley—a magnificent drive, and one that would have been most enjoyable had not the weather compelled the use of closed coaches, which afforded anything but a pleasant means of locomotion on a warm August afternoon. Arriving at the George Hotel, Knutsford, tea was served; and then the merely formal business of the day was transacted.

The Hon. Secretary (Mr. S. S. Mellor) read the minutes of the previous meeting held at Morecambe, and the qualifications for membership of the two gentlemen applying for admission—Mr. James W. Wynne, of Ambleside, and Mr. Henry Froggatt, of Bollington. They were duly elected.

The party then broke up—part returning by train to Manchester, the rest by coach to Warrington—after a day the full enjoyment of which was only marred by the wet weather prevailing during what would otherwise have been the best part of the time the members were together.

WAVERLEY ASSOCIATION.

HALF-YEARLY MEETING, SEPT. 8.

This Meeting was held at the White Swan Hotel, Duns—Mr. J. M'Laren, of Duns, the President, in the chair. There was a good attendance of members and their friends.

The Hon. Secretary (Mr. W. B. M'Lusky, of Selkirk) stated that he had not thought it necessary to prepare any report for the Committee who were appointed at the preceding meeting with reference to the efforts of the North British Association for the standardizing of meter-unions. They were all aware of what had been done in the interval. The matter was now in the hands of the Council of The Gas Institute; and they had not thought it needful to take any action upon it.

The decision of the Committee was approved; and they were continued in office.

The President's Address.

The President then delivered the following address:—

Before commencing my address, I must thank you for the high honour which you have bestowed upon me in electing me President of the Waverley Association of Gas Managers for the present year. When I was proposed for this office, at a meeting last year, I could not but appreciate the great compliment. But I felt considerable doubt as to my ability to fill the post satisfactorily; and it was only with the firm conviction that I could, if selected, rely on the help, not only of the Association, but also on the help of all of you, that I agreed to my name being put before you for the post. I have already felt some of its numerous responsibilities and worries; and not least among these is the preparation of an address. If I could set before you something entirely new in gas undertakings, I might feel justified in asking your attention for some short time. But as I have nothing new, I must throw myself upon your mercy, and ask you to excuse and overlook all my manifold defects. The few remarks I am about to make are simply intended to show some of the difficulties the manager of a small gas-works has to contend with.

In speaking on this subject, let us imagine a works making (say) from 5 to 10 million cubic feet of gas per annum, and suppose the works are old and out of date—too small to meet the demand put upon them in midwinter—and also that the company cannot afford to, or will not, reconstruct the works, or that they think reconstruction will not repay the outlay. Not a very bright outlook, you will say. Well, no, I grant that. But how many managers of small works have much better? Let us first of all examine the duties of the manager of such a works. He has to be on the works early in the morning, to act as his own timekeeper, and to see that all his plant is working properly. He is, naturally, responsible for the correct working of the concern, has to keep all books, and sometimes, when called upon, to be his own stoker, main-layer, fitter, and, if pressed, his own labourer. He has also to inspect meters, look after the public lamps, and, when necessary, do all testing and drawing. He is liable to be, and frequently is, aroused in the night to attend to some accident on the works. Of course, his chief object is to make as much profit as possible. This is no easy matter with the plant he has to work with; added to which he will have to pay heavy carriage on coal and residuals, as small works are usually out of the way of collieries, and often far from a good railway line. If you inspect his retort-house, you will see that he has three single benches of three retorts—nine retorts in all. His furnaces are direct-fired—burned beyond repair, as likely as not—and his retorts are patched and cracked. These he has to make work by some means or another.

In small works as in large, the retort-house is the most vital part, more especially as regards money-making; and upon the efficiency of the carbonizing plant proper depends the financial results of the business. If money is lost there, or the working is not economical, no amount of care and attention afterwards will be of much benefit. He cannot work as cheaply as in the case of large works. Even though his plant is good, he cannot compete with works using stoking machinery, inclined retorts, and other labour-saving appliances. Besides, these would not pay in so small a place. The works will be too small to allow of storing coal in any quantity. This places him to a great extent in the hands of the colliery proprietor who holds his contract for coal, as regards the running of waggons, which will run fast enough in summer when neither he nor anyone else wants them; but in winter, when the demand for coal is high, he has a great deal of bother to get any coal at all. And when he does get it, it is wet through, or may be covered with snow; and it has to go into the retorts just as it is, much to the detriment of the heat of the setting.

In midwinter it will suddenly spring upon him that the beds cannot be got hot, and no one knows the reason; or else he finds out that there is no draught up the chimney, nor can he obtain any. Then, after almost superhuman efforts, he discovers that the main flue is blocked with dirt, ash, or dust. This he manages to clear temporarily. Then either his exhauster will stop or some of his connections will get blocked up with accumulated tar and liquor, &c.; thus causing a big back-pressure, and not unfrequently blowing the liquid from his hydraulic main into the retorts. If in midwinter, when the whole of his retorts are working, a fog should come on suddenly, and the consumption owing to this become greater than the make, he has to get up furious heats in as short a time as practicable, to obtain the greatest possible amount of gas in the least possible time. This is often the source of trouble with the ascension-pipes, as a thicker tar is produced, which forms pitch sooner than lighter tar would. Or, if the benches are not in the very best condition, an arch may drop in; and perhaps a retort or two may then get burned through.

From the retort-house, the gas is led through the foul main to the condensers. This main may be a 6-inch one, which is far too small; and the condensers may be totally inadequate to cope with the full make from all the retorts. Then, again, the 6-inch main may have filled up badly in the years it has been down, and the condensers and inlet and outlet of the scrubbers may be in the same state; and it would be nothing new for the pipes to choke up and put the works in a mess with back-pressure. The exhauster may suddenly break down, causing such a pressure that it would be easier for the gas to find its way through the porous sides of the retorts than against the pressure thrown by all the different pieces of apparatus. The manager will then have to set to work and repair the exhauster; for he has no other to put on in cases of this sort, and this one may have been working for years, and not have been touched in the way of repairs.

The purifiers will be too small for the maximum make—in fact, they will hardly last for three days in the busiest season; and if one is taken off to put fresh oxide or lime in, the remainder go dirty sooner, as they have more work to do. The purifier centre-valve may be old, and the faces not true, in which case the gas will leak from one purifier to another. There may also be a water-valve or two about the place; and these have a very nasty way of freezing, or going wrong just when wanted. The station meter may be too small, or out of order—useless, perhaps—in which case the manager does not know what amount of gas he is making or delivering. If his gasholder is far from the boiler (supposing he has a boiler), so that he cannot get steam into the cups, it is quite usual for the water to freeze in winter and bind the holder. Should this happen in the morning, when the consumption of gas is less than the make, a pressure is thrown which will blow the water out of the purifier lutes. If it should happen at night, when the consumption is greater than the make, the holder becomes fixed, and the pressure gets less and less, until at last the town is put into darkness.

The manager of a small works is quite as much troubled with naphthalene deposits as the manager of a much larger works. Besides the troubles known only in small works, he has to contend with the same as his better-off brother in the large works. He has, like the manager of large works, to attend to the complaints of the consumers; keep the gas free from impurities, and above, or at least equal to, the candle power prescribed by his Act; to keep order; and, above all, to "make money."

And now I will not detain you any longer. I have tried to keep as near my title as possible; and in so doing I am afraid it may appear to you that I have been relating a chapter of accidents. But, at the same time, I think I have shown some of the difficulties that managers of small works have to contend with. If I should have succeeded in interesting you for a short while, I shall have attained my chief object.

Discussion.

Mr. H. RUTHERFORD (Aberlady) said he thought they ought to thank Mr. M'Laren for his address. He had shown them many difficulties which a small gas manager had to encounter.

Mr. D. VASS (Edinburgh) said he could quite bear out what the President had said—that many of the difficulties which he had pointed out faced them all on entering upon duties in works which were strange to them. The first winter in a new works was a very trying time to any gas manager. Even in the smallest works, a new manager should, during the first summer he was in charge of them, make a thorough inspection of the whole plant. This would enable him to overcome many of the difficulties which had been mentioned. By such inspection, they would find out, for instance, if the main flue was clear, or could have the condensers steamed, supposing there was steam on the works. The washer and the exhauster could be looked at; and he thought it was always advisable to employ a mechanic in the summer to overlook the exhauster. His experience was that, if if they tried themselves to patch up the exhauster, it might go wrong just at the time it was wanted. Even if it were overhauled by a mechanic, an accident might take place; but then they would have the satisfaction of being able to say that they had done the best they could to prevent any such difficulty. The President had confined his remarks to works of from 5 to 10 million cubic feet; but the same difficulties were to be found in works as large as from 20 to 40 million cubic feet. Of course, in the larger works there was a bigger staff to deal with difficulties; and they might be got over sooner. One little trouble which he had to overcome, and which could not be foreseen, was with what was called a self-acting trap. He believed they were not unusual in distributing-mains. In this particular case, it had been put on when a new 10-inch main had been laid from the holder; and it gave no trouble for years. One evening, the pressure suddenly fell; and had it not been for a small district holder, it might have gone down to 2-10ths or 3-10ths. As soon as the decrease was noticed, the holders were reversed, and arrangements were made to fill one which was nearly grounded. It took them about three days to find out the defect. A lead pipe had been laid, to work by a syphon arrangement; and there having been a flood in the district, the water, instead of having been drained off by the syphon, had been drained in, and had filled the main to a few inches from the top.

Mr. W. Blair (Haddington) said they all knew very well that small gas-works were a training-field for managers for larger works. He had had experience in both small and large works. As the manager of a small works, he had always made it a point, about this time of the year, to thoroughly overhaul the whole of his plant—to take particular notice of the condition of the pressure-gauges and such things, and of how the gas was going right up to the holder. And he might say that he had never experienced a complete choke-up; he had never had anything which could not be remedied in a few minutes. He had had his trials and his difficulties, like others; but he had always found that attention to the matters he had mentioned enabled him to get on very well. In Haddington, he had not had a cap or pipe open for the last seven years, except for these inspections. He had a small steam-boiler; and he found that by it he could clear away, in five minutes, any obstruction which was likely to occur between the gas outlet and the purifiers. He had an exhauster and washer, and almost all the recent appliances which could be introduced into gas making. He had found the re-modelling of the works to be of the greatest advantage. They had reduced the price of gas from 5s. 10d. to 4s. 7d. per 1000 cubic feet. He thought that even in works down to a million cubic feet, it was worth while considering whether they should not introduce the latest appliances. He had no doubt it would be found to be of advantage in the long run—at least, this had been his experience. With reference to pitching, he might say that, in cases where retorts had been lying off, it was advisable, before they were re-started, to examine the dip-pipes, because there might be found, at the bottom of them, an incrustation, which could be easily cleared away, but which if left would obstruct the passage of gas.

Mr. A. C. YOUNG (Kelso) said he had always found that the bane of a gas manager's life, in winter, was the thing which happened suddenly. This trouble all his life had been with the hydraulic main pitching up. It was a difficulty he had never been able to overcome. He had found that high heats were always the cause of it. He should be very pleased to know how it was to be got over, because some managers held it was the coom, or gum, of the coal, especially in the case of small or drossy coal; while others said that it was the rich cannels, such as Newbattle. He had found it to take place even with common cannels, when the heats were high. Condensers were very apt to choke; but, as Mr. Blair had pointed out, if they were cleaned out regularly, this might be avoided. It was a very good thing to have steam ready to be turned on in a moment; but he had never found steam to cure the pitching. He had heard that running water was effectual in preventing it, but had not found it so. He had had to take off the mains and remove the pitch by means of hammers and chisels, which was sometimes a very dangerous operation.

Mr. BLAIR said he employed as high heats as anybody. He produced close upon 11,000 cubic feet of gas per ton of coal; and this, he thought, was a sign that he used fairly high heats. He might sometimes have tough tar in the hydraulic main; but he would not call it pitch. In his main he had a baffle-plate fitted in front of the hydraulic valve, dipping 2½ inches into the liquid, and rising the same distance above it, so that all condensable matter had to go beneath; and he was not bothered with any pitching whatever in his main. He used the best cannel which was to be found in Scotland. He thought that pitching was, to a very great extent, caused by the dips in the hydraulic main being really below what they should be. As to stopped ascension-pipes, if they were properly cleaned out at each charge, there should be no trouble in this way. It was only when they were neglected, or the carbon or sooty matter was allowed to gather on the first 18 inches of the retort, that there was any trouble.

Mr. W. SMITH (Melrose) said he had listened with great attention to what had been said. With reference to the stopping of ascension-pipes, it occurred to him that the cause of this might be that they were too small. He had often been troubled in this way when working with high heats; but when using low heats he had never had any such difficulty. He thought that Mr. Blair did well in getting up to 11,000 cubic feet of gas per ton of coal. If he (the speaker) could do this, he would have a more favourable balance-sheet at the end of the year.

Mr. G. TAYLOR (Jedburgh) remarked that, like Mr. Blair, he had a baffle-plate in his hydraulic main; and he was never troubled with pitching. He found, if the pipes were slanting in a certain direction, that there might be thick tar, not pitch; but that if they were put right this went away. He thought if the hydraulic main were too close to the bench it might cause pitching. He found steam of great benefit. One winter he had to pump a trap regularly. He put a steam-pipe down, and it cleared it at once, though it was much pitched up.

The PRESIDENT said he quite agreed with one or two of the remarks Mr. Blair had made. He recollected once, in Ireland, he had three retorts working and three lying off; he started these three, and his gauge went up dreadfully. There was a sort of tarry matter gathered at the bottom of the dip-pipes, but no pitch; and he must say that, through all his experience, he had never had any difficulty with pitch in his hydraulic main. But he could not agree with Mr. Blair in regard to ascension-pipes. Ever since he had been at Duns, he had had great trouble with them in the dead of winter. When he had to use a high heat, to force matters, he was badly troubled—not with pitch, but with a thick sort of tar. It occurred at the very top of the cap, just before entering the hydraulic main. The pipes were always clear at the bottom.

Mr. BLAIR said he would recommend that there should be a cross current of ventilation at the level of the top of the retort-bench.

The HON. SECRETARY thought they might get a little nearer to the point. Mr. Young's difficulty, if he understood it aright, was not so much with the quantity of gas which was being taken off per ton of coal. It was rather the quantity the coal was capable of producing; and that immediately they began to distil the condensable hydrocarbons they had a choke, as they were bound to have. At Selkirk, where they had fairly good settings, they could, with Newbattle cannel, for example, obtain 11,500 cubic feet of gas per ton. This was quite an ordinary make. But if they attempted to obtain 11,000 cubic feet from (say) Meiklehill, or any of the common coals, they had chokes immediately. Now, in Mr. Young's case, he had excellent heats, and the coals were all new to him; and his (the speaker's) opinion was that the trouble was due to coom. The reason he took such an interest in this matter was that he had chokes for the very same reason that Mr. Young had. He had drawn out ropes of pitch about 18 inches long, when using English coal at high heats; but whenever he used Scotch coal mixtures, getting the same satisfactory results from the coal carbonized, he had no stoppages. He believed that in every case, provided the plant was of the proper size, stoppages were due to over-distillation of the coal. They could not expect to take so much gas from an ordinary coal as from a rich cannel.

Mr. Vass supposed that Mr. Young did not mean them to understand that he was troubled with pitch in the proper sense of the word, but with thick tar. He himself was troubled with tar accumulating to such an extent that it would not blow by the ordinary valve. The valve was arranged so that the tarry matter should be drawn from the main first, and should leave only liquor in the main. In this particular case, the gas outlet was at the top of the main. The tarry matter got so thick that it would not flow; and they were troubled with back-pressure. He considered that the trouble was due to heat radiated from the bench. There would be about 18 inches between the top of the bench and the bottom of the hydraulic main; and the arches of the ovens had been made particularly light, as it was thought that they would rise and fall much easier, and would thereby have greater durability. The crowns of the arches would be about a brick and a half thick. They had to bore the end of the main, and steam the tar, in order to run it off. Now, if they found that there was the least tendency to pitch, they put steam through for about five minutes; and to get rid of the radiated heat, they placed a course of loose bricks along the edges of the bench, and filled in sand, leaving about a foot of space between the top of the sand and the hydraulic main. With this, and occasional steaming, they had been able to keep the main practically clear. He agreed with Mr. Blair in the matter of ventilating the retort-house. During the first winter he was in Portobello, they had a very close retort-house; and every night they had choked pipes. That winter he had enough to do to keep his men working, as they threatened to leave on account of the choking of the pipes. He had since changed the position of the bench. There was now much better ventilation in the retort-house; and there were not so many choked pipes.

Mr. J. C. ADAMSON thought that, somehow or other, the conversations at their meetings were perhaps more productive of good to the younger gas managers than what took place in the larger Gas Associations, where subjects which to those in large works seemed trifling did not engage full attention. As a manufacturer of plant for gas making, he might say that they had the advantage of coming into contact with all varieties of apparatus—for each gas manager sought to devise something to carry out his own ideas—and in this way they gathered a more general knowledge of what was best adapted for the purpose. His experience was that the baffle-plate in hydraulic mains was almost universally used now; and, so far as he knew, it had never failed in its object. He would suggest to their minds something which had not been referred to. He did not know if it had been observed by any of them that the manner in which the ascension-pipe was placed had sometimes to do with the choking of it. Supposing the ascension-pipe were inclined, as it went up, towards the retort-bench, the radiated heat from the bench would strike the side of the pipe down which the condensable matter was running, and there would be, more or less, a re-distillation of these products, leaving solid matter behind, adhering to the pipe, and tending to choke it up. If, on the other hand, the ascension-pipe lay away from the bench as it went up, the condensable matter would run down the cold side of the pipe, and would not be affected by the radiated heat. He did not say that this would take place in every retort-house, because, where they had the cross currents Mr. Blair had spoken of, they would help to a great extent to neutralize the effect of the radiated heat.

Mr. TAYLOR said he could corroborate Mr. Adamson's statement. In his place, the ascension-pipes all hung out at the top. They had been in position for seventeen years; and there had never been a choke in an up-pipe, though there had been in a cross-pipe.

The PRESIDENT expressed his pride that his address had led to such a good discussion, and thanked them all for the way in which it had been received. While Mr. Adamson was speaking about the lie of the ascension-pipes, he was thinking of his own retort-house; and he now recollected that the pipe which had troubled him most lay inwards to the bench at the top. The cross-pipe had been cut too short; and the ascension-pipe had been given an inward slant to suit it.

CONCLUDING BUSINESS.

The question of the next place of meeting was then considered; and it was resolved that, while no hard-and-fast rule should be adopted as to the holding of the Spring meetings in Edinburgh, the meeting in April of next year should be held there, and that the meeting in September of next year should be held in Melrose—the date in each case to be, as usual, the second Thursday of the month.

The PRESIDENT asked for information regarding the insurance of gas-works against fire or accident; and several members informed him as to the rates which they were charged. The rates varied according to the class of risks, and averaged from 4s. to 4s. 6d. per £100.

This concluded the business of the meeting.

The dinner was afterwards held in the same hotel—Mr. M'Laren presiding.

THE ORIGIN OF GAS ASSOCIATIONS.

Mr. J. C. ADAMSON (Airdrie), in proposing the toast of "The Waverley Association of Gas Managers," said that the Waverley Association was the parent of all the Gas Associations or Gas Institutes in the country, and so far as he knew in the world. He congratulated the gas managers of to-day on living in such peaceful times. It was not always so. There was once a man named George Flintoff (whose death was noticed some two or three years ago in the *Journal of Gas Lighting*), who was possessed of a voluble tongue, and having agitated the gas consumers and others in several towns in England, with more or less success, he thereafter turned his attention to Scotland, where he arrived about the year 1860, and commenced a crusade similar to that which he had been carrying on in England. Not long ago he came across a printed bill which he then held in his hand. It had been published by a Committee which Flintoff had succeeded in forming in Denny about July 1860. In the bill the Committee announced "the engagement of George Flintoff, Esq., the Gas Engineer from London, who has exposed gas abuses and saved more than £250,000 [not of capital but] a year to the gas consumers of a number of towns," and who was to "deliver a lecture on the Sale of Gas Bill and the various meter frauds practised upon the public." He succeeded in Denny, as he did in some other towns in Scotland, in inducing a number of people to back him in the formation of a Consumers' Company and in the planting of a gas-works. From the West of Scotland he was working his way eastwards; and he arrived, if he (Mr. Adamson) remembered aright, in Dalkeith, where the late Mr. John Young was Gas Manager and already a veteran in the gas world—the father of Mr. William Young, of Peebles. Mr. Young tackled Flintoff in debate on the public platform in Dalkeith and elsewhere; and by an exposure of many of his misstatements he sought to "hold the fort" for the gas profession, to which Flintoff was by his agitation causing injury. At that time coal was dear, and gas plant and gas knowledge not in such an advanced stage of perfection as it was to-day; and there might be some defects from which a person who was seeking to raise an agitation might possibly find some help. At that time the late Mr. Robson, the Gas Manager of Selkirk, and himself—then Gas Manager at Galashiels—were in the practice of meeting at each other's houses on alternate Saturday evenings over a social cup of tea. In talking over the burning gas question of the hour, either Mr. Robson or himself, he forgot which, put forward the question, Could nothing be done to stem the tide of this agitator who was causing such trouble and annoyance to gas managers? The suggestion then arose between them, that a Gas Managers' Association should be formed for mutual advice and help. Mr. Robson sent out invitations to the gas managers in the Waverley District, convening a meeting in Kelso. Some eight managers were present; and the Waverley Association of Gas Managers was then duly formed, with Mr. Clazy, of Kelso, as the first President, and himself as the first Secretary. Mr. Mackenzie, then the Manager of the Cupar-Fife Gas-Works, and afterwards of Dunfermline, was a gentleman to whom he (the speaker) had been indebted; having been his apprentice-master when he was qualifying himself for a gas managership. When writing to him, as he did regularly at that time, he told him of the Association the gas managers of the South of Scotland had formed. Mr. Mackenzie at once adopted the idea as a good one for his district; and he and his nearest neighbour Gas Manager, Mr. John Loudon, of Ceres, took the necessary steps which resulted in the formation of the Fife and Kinross Association. This afterwards merged into the Scottish Association; and from this afterwards arose the West of Scotland Association. And now all these were merged in the North British Association. He was glad that the Waverley Association maintained intact the individuality of their Association which was the parent of all other Associations; and he hoped that they would long live and flourish. He was glad to meet that day, as he had done when living in Galashiels in the early sixties, so many kind hearts among the gas managers of the Border towns; and he trusted they would go on meeting for many years to come, and find both profit and pleasure in each other's company. He had been asked to couple the toast with the name of their present respected Secretary, Mr. M'Lusky; and he thought nothing could be more appropriate than that he—the Secretary of about forty years ago—in proposing the Waverley Association, should couple it with the enterprising Secretary of the present time.

The members and their friends afterwards drove to Manderston House, the seat of Sir James Miller, Master of the Berwickshire Foxhounds, which they had received permission to visit, and where they were privileged to witness the garden and the hunting arrangements. The weather was favourable for the outing, which was much enjoyed.

EASTERN COUNTIES ASSOCIATION

HALF-YEARLY MEETING, SEPT. 15.

This Meeting was held at Romford, under the presidency of Mr. W. D. CHILD, Engineer and Manager of the Gas Company. It is a matter for regret that only a small proportion of the members attended; but their absence was counterbalanced by the presence of a number of visitors. The place of assemblage was the gas-works; and there the members received individually a cordial greeting from the Chairman of the Gas Company (Mr. Joseph Smith), his colleagues, and the President. The principal feature of interest on the works was the retort-house, containing retort-settings heated by the regenerative furnaces which were described to the members in a paper read by Mr. Child in 1894.* The construction of these was examined by the visitors, who were also enabled to witness the charging of the retorts by West's manual stoking machinery—the ease and rapidity with which two men performed the operation being freely remarked upon. Having completed their inspection, the visitors partook of luncheon, courteously provided by the Directors; and afterwards they were conveyed by brakes to the District Council-Room, where the business was transacted.

The PRESIDENT, on taking the chair, remarked that it was customary for the retiring President to introduce his successor; but he was sorry to say that Mr. J. T. Jolliffe, of Ipswich, who conducted the affairs of the Association so well during the time he was in office, was unable to be present through indisposition.

CONFIRMATION OF MINUTES.

The HON. SECRETARY and TREASURER (Mr. J. H. Troughton, of Newmarket) read the minutes of the previous meeting, and they were confirmed.

NEW MEMBERS.

The PRESIDENT proposed, and Mr. H. WIMHURST (Sleaford) seconded, the election as members of: Mr. Joseph Davis, of Gravesend, and Mr. Frank Clark, of Southend-on-Sea.

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* See "Reports of Gas Associations" for 1894, p 264.

The **President** then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—When I call to mind the few years that I have been connected with the Eastern Counties Association of Gas Managers, I fully appreciate the honour that you have done me in selecting me as your President; and I am at the same time impressed with the responsibility imposed upon me to maintain the work of the Association at the standard to which it has been brought by those who have preceded me in office.

I trust it will not be considered out of place if I take this opportunity of thanking the retiring President (Mr. J. T. Jolliffe) for the great interest he has taken in the affairs of the Association during his term of office, for the tact displayed in promoting discussions both interesting and valuable, and for the generally enjoyable character of the meetings. During the past few years, the members of the Association have received most cordial welcome at the towns they have visited—both from Municipal Authorities and from Directors of Companies; and this of itself is most gratifying, and may be taken as an indication that the efforts of the members to effect improvements in manufacture, and to extend the use of gas, are appreciated by those interested in gas undertakings.

At the meeting in Ipswich last autumn, the Chairman of the Gas Company (Mr. Biddell) spoke in terms of high commendation of the useful character of the work done by this and kindred Associations in maintaining the values of gas properties in the face of keen competition from other illuminants; and he said that this had been legitimately accomplished by the introduction of devices for reducing the cost of labour, and the quantity of material used in the production of gas, and by perfecting systems by which the consumers can obtain the highest value from the gas, whether used for lighting or for heating. Such remarks, coming from a gentleman whose life had been passed in the successful management of a large engineering business, are a great encouragement to these organizations to extend their researches and operations.

Some short time ago, a most interesting letter appeared in the *Gas World*, advocating the formation of a Junior Gas Engineers' Association. It was at once pointed out how difficult it would be to carry on such a Society, owing to the manner in which gas engineering students are scattered over the length and breadth of the land; and I venture to express the opinion that the number of Gas Associations already in existence render any addition unnecessary. The fact of a student having successfully passed examinations, and obtained Honours from the City and Guilds of London Institute, should qualify him at once for admission to any of the District Gas Associations, and, under certain conditions, to The Gas Institute. Such a course would meet the views of the writer of the letter, by enabling students to attend the meetings of men having a more extended practical and theoretical professional knowledge than themselves, and to take part in their debates. The introduction of such young men, whose ideas, full of the freshness and vigour of youth, had been directed into proper channels by an intelligent and well-regulated course of study, would be a great benefit. If they would take their part in the work of the Association by providing papers, or even introducing subjects for debate, and would let themselves go—not being content to be mere silent members—they would be distinctly welcome. They might, and probably would, make mistakes. But better that than do nothing; for the correction of such mistakes would prove a valuable education to themselves and their seniors, and if carried out in the kindly spirit and with the courtesy they might reasonably expect to receive, might prove the foundation of many friendships. If at times they experienced a little rough handling in the way of criticism, it would only be a slight foretaste of what they must be prepared to receive later in life when controlling works themselves.

While on this subject, it may be useful to remark upon what has to me always appeared an astonishing peculiarity—viz., that the selection of men to control works for the manufacture of gas (a distinctly chemical operation) should be made from a class who have made mechanics, rather than chemistry, their particular study. The duties of a manager of gas-works are varied, requiring an extended mechanical, as well as chemical and commercial training. But that the proposition I have laid down is correct is, I think, conclusively proved by the character of the papers and discussions at our meetings. Early training will assert itself; and the frequency of papers having a valuable technical engineering character, and the heartiness and thoroughness of debate upon them, can but be contrasted with the scarcity of papers having a distinctly chemical basis, and the hesitating, doubtful manner in which such purely chemical subjects are treated. The modern student, especially trained for the gas profession, has his attention directed as much to one branch of his profession as the other, and becomes a chemical engineer; and I therefore strongly advocate that the Gas Associations now in existence should give every facility for the admission of these young students, whose presence cannot fail to be of assistance and value to all concerned.

The members of this Association were, I am convinced, actuated by good fellowship toward myself, more than by expectation of seeing anything new or remarkable in the works under my charge, when they decided to visit Romford. The works, as you are aware, have only been built a few years—gas making having been commenced in September, 1892. It was an unfortunate thing for the Company that, after the establishment of the old works in 1847 on a site having an area of about one-third of an acre, residential property was gradually built in the neighbourhood, until, as business increased, it proved a great obstacle to enlargement of the works. Everything that was possible was done to put off the inevitable removal. The one-third of an acre ultimately contained all the buildings and plant for manufacture, purification, and storage, in addition to the Manager's residence and the Company's offices; and during the last winter that the works were in use, 170,000 cubic feet of gas were sent out daily, with storage capacity for only 53,000 cubic feet. I am thankful that some modern methods had not at that time been more fully developed, or it is possible that, with a water-gas plant, and purifiers roofed in with a gas-holder tank standing upon brick piers, I might even now be struggling in that cramped site, with unceasing anxiety to myself and discomfort and disadvantage to all concerned. At last it became a necessity to acquire other land, and to build entirely new works. For a small Company, the abandonment of works in running order was a great sacrifice, and likely to prove a heavy burden in the future. It was therefore imperative that no expenditure of capital should take place that was not expected to prove immediately productive; and it would be an injustice to my Directors and myself if I failed to assure you that the design and erection of the new works received most careful consideration, with the desire that on completion they should in all respects be equal to the requirements of both shareholders and consumers. The work that was carried out was all substantial, thoroughly good, and in no way stinted; but nothing was spent upon ornamentation, or in providing plant that was not required for immediate use, or that was not expected to effect saving in labour or material. The leading ideas were to secure and make use of railway communication for the delivery of all material; to adopt the best-known method of handling and carbonizing coal; and to provide plant for the effective purification of the gas, and as much storage as would enable every economy to be practised in manufacture, and furnish an unstinted supply of gas to the consumers of all kinds. The distributing plant was added to, and where requisite rearranged; but so little was done in the principal thoroughfares that, when the works were nearing completion, I was several times asked when, and how, they would be connected to the existing supply. Having a considerable day consumption by gas stoves and engines, we give a minimum initial pressure of 15-10ths. Yet the unaccounted-for gas has been kept within fair limits. The past two years averaged 4·5 per cent.; and during the last half year, with 21 miles of mains for an output of 20 million cubic feet, the loss was only 3·29 per cent.

The retort-house (fully described in a paper I read at our Yarmouth meeting in 1894) contains settings of retorts heated by regenerative furnaces; the charging of the retorts is done by West's manual stoking-machines; and the hydraulic is fitted entirely with anti-dip valves. After some twenty years' continuous working, my belief in the advantages of the anti-dip system is fully confirmed. So far the arrangements are on modern lines. But on consideration of the varied plans I have seen for effecting condensation—foul mains of large diameter extended in long lines on the walls of the buildings, as far as their size would permit, and condensers, annular and otherwise, so powerful that two-thirds of their capacity had to be shut off—I determined to be more moderate.

The gas is taken by a pipe from each length of hydraulic main, and, crossing the bench, is connected to the foul main, which runs by the most direct route to the condenser—indeed, I may say that the whole of the plant was purposely arranged for the connections to be as short and simple as possible. Rather than run a long length of foul main of large diameter round the building—a method frequently practised—I preferred to spend a portion of the value upon a vertical tube fitted with perforated discs, and subject the gas to a process similar to what the late John Somerville termed "hot frictional condensation." After this the gas is condensed in an annular condenser before being passed through the exhauster. It is then washed with strong liquor in a Livesey washer, scrubbed, and finally washed with water in a Cockey's washer. The dry purification is performed with alternate layers of lime and oxide of iron; the boxes being worked on the rotary system.

Nothing was expended upon buildings to cover either purifiers or oxide of iron in course of revivification. If buildings are erected over purifiers, the work should be done thoroughly

—*i.e.*, in such a way that control may be maintained over the temperature of the gas in course of purification. But when (as s most frequently the case) the purifier-house consists of a draughty building, a mere roof covering supported on columns or brick piers, the purifiers themselves being carried some height above the ground on iron girders, with all pipe connections underneath, exposed to cold, cutting draughts, then I would rather save that expenditure and bury my purifiers and pipes as deeply in the ground as possible, and so preserve an equable temperature, and also give support to the boxes, which are at times subjected to heavy strains.

As having some connection with this latter remark, and to show that the point must be taken into consideration, I may say that, during the early part of last winter, I was using some natural bog ore of rather inferior quality; and thinking to improve matters, I purchased some manufactured hydrated oxide of iron. This was mixed with old bog ore and sawdust—an equal bulk of each of the three ingredients—and charged into the purifier in two layers, each 18 inches thick, with a space 6 inches deep between the layers. This mixture absorbed the sulphur from the gas so rapidly as to considerably increase its bulk, with the result that the cast-iron sides of the box were unable to resist the strain, and the plates were broken from top to bottom on each of the four sides. I have nothing to say against the purifying material in question—indeed, I am still using it, but under different conditions. I do think, however, that the vendors were not as careful as they might have been in drafting the directions for use sent out with the material, as I find that my experience was not a solitary one.

Returning to the question of expenditure on purifying plant I repeat that, having a certain sum to expend for the purpose, it will be found better to utilize it in purchasing the largest purifiers that can be had for the money, than to fritter away a portion of it on buildings that are of no practical good. A purifier-house designed, and sufficiently well constructed, to be of service in regulating temperature, will be found a costly addition; and unless great care is exercised when opening the boxes for the purpose of changing the material, it might easily prove dangerous. The works under my charge are capable of producing about 250,000 cubic feet of gas daily—perhaps slightly more; but I limit my estimate of the productive capacity to this amount because I am of opinion that when plant is worked beyond a fair limit, leaving no portion available for use in case of emergency, wasteful expenditure of labour and material at once begins. The gas-works that are always kept slightly in advance of maximum production can be carried on most economically, even though the capital may thereby be slightly increased. Some managers may experience difficulty in obtaining the sanction of their boards for every expenditure on plant which may not only appear advisable, but which their daily experience tells them is absolutely requisite. The manager may even be reminded that the winter season is passing away, and that troubles caused by some insufficiency of plant will soon be over. But it must not be overlooked that in this country many works manufacture as much gas in the four winter months as in the remaining eight, and that if half the work of the company is carried on in the busy season of the year under adverse conditions, with consequent waste, it cannot be made up by successful working during the period when the plant is capable of dealing properly with the quantity of gas required. Through circumstances beyond the control of my Board, I had ample experience of the difficulties of working with insufficient plant; but I am happy to be able to say that this condition of affairs has passed away. The difficulty experienced during the past two years in finding a ready market for coke, at times made me wish that we were not quite so well provided for, and that I had sufficient cause to justify putting down some plant of another description. The design of these works was such that extensions would be so in reality, and would not necessitate altering or disturbing work already executed; and nothing beyond the manufacture of coal gas was contemplated.

During the past few years, great progress has been made in this country with the erection and working of plant for making carburetted water gas. The process, worked in conjunction with coal gas manufacture, appears to possess so many advantages that I shall be very pleased when the growth of this Company's business necessitates further additions to plant, and, regardless of the objections that have been raised in some quarters, I shall advocate the adoption of this system of manufacture. I have no doubt before that time arrives the Home Office Committee will have fully considered the allegations that have been made as to the dangerous character of water gas, on the ground of its containing a larger percentage of carbon monoxide than is found in coal gas, and will have determined what restrictions (if any) shall be placed upon the use of carburetted water gas, and the proportions in which it may be combined with coal gas and supplied with safety and advantage to the public. The President of The Gas Institute

(Mr. James Stelfox), in his address at Belfast, dealt at considerable length with this phase of the subject; and I think he conclusively showed that the objections raised were more fanciful than real. During the fifty or more years that coal gas has been in common use, the public have learned that it is both disagreeable and dangerous when allowed to escape into their houses; and they therefore take proper precautions to prevent such occurrences. If the compound gas is more dangerous, it is equally disagreeable, and will make its presence known as quickly; and it is therefore likely to receive the same amount of attention that has sufficed for the protection of the users of ordinary coal gas. The advantages of the carburetted water-gas system may be summarized as follows :—

1.—The small amount of capital required for any stated production (say) beyond 150,000 cubic feet per diem, compared with coal gas.

2.—The small space occupied by the plant, thereby reducing the cost of buildings; and its simplicity of construction, resulting in low cost of maintenance.

3.—The control given by the use of the plant over the production and sale of coke.

4.—The fact that enlargements of carbonizing plant do not necessitate a relative increase of coal storage, but may enable deliveries of coals to be more equal through all seasons of the year.

5.—The readiness with which any accidental lowering of illuminating value in the gas may be corrected, and the steadiness with which the gas may be maintained at any desired standard.

6.—If gasholder capacity is insufficient for the consumption, then the water-gas system, with its rapid production, may be brought into use during hours of maximum consumption, to assist in keeping the holders full and the supply to the consumers properly maintained.

7.—If there is ample storage capacity, then a smaller number of retorts may be kept in action than would otherwise be required—especially during the summer months; and as the gas stock runs down, and becomes reduced as low as may be considered a safe limit, the water-gas plant can at once be put to work, the gasholders be filled up in a short space of time, and the use of the plant then as readily be discontinued until again required. This method of working could be carried on with safety. Indeed one member of this Association who has experience in working the plant assures me that, starting all cold, the apparatus may be prepared and making gas within four hours.

8.—The valuable qualities carburetted water gas possesses for clearing away naphthalene obstructions, either from works plant and connections or from mains and services.

9.—The greater feeling of security on the labour question, as the number of men required is much smaller, particularly in using plant of large productive capacity; and the class of men employed, being rather superior in training and intelligence to the ordinary stoker, are more subject to control. I have read remarks from some gentlemen deprecating the introduction of a system that would have a tendency to decrease the number of men employed; but personally I have no feeling of sentiment on this score. In this locality, at all events, work is so plentiful that difficulty arises in finding suitable men; and no honest, industrious man need be without employment.

With regard to coke, the value usually appears to be quite local in character, and to decrease as the quantity in stock at the works increases. The sight of a large heap of coke in the yard makes a would-be purchaser utterly indifferent about buying, unless at a ridiculously low figure; and I think that, when stock grows beyond a certain limit, it is wiser to cut the loss by one quick sale at a low price than to attempt to stock the coke in hopes of a better market. During the past two winters, our works became so overstocked with coke that, though possessed of plenty of carbonizing plant for the production of coal gas, I seriously contemplated recommending to my Board the erection of water-gas plant with the object of reducing the output of coke and turning the stock we had in the yard to better advantage than by selling at the low price we were compelled to accept.

My idea was to put down plant equal to a production of 200,000 cubic feet per 24 hours, and to work it from 8 to 12 hours daily, and so produce about 80,000 cubic feet of water gas. A daily make of 200,000 cubic feet of coal gas would require the carbonization of about 18 to 19 tons of coal, producing (say) 13 tons of coke, of which about 10 tons would be sent into the yard for sale. These figures are only approximate. Now, if 80,000 cubic feet of carburetted water gas were made, leaving only 120,000 cubic feet of coal gas, the result would be that only 11 tons of coal would be used, producing from 7 to 8 tons of coke, of which 5 tons would be available for stock. But this quantity would be further reduced by the 32 cwt. required for the water-gas plant, so that the quantity for daily sale would be only 3½ tons, instead of 10 tons as in the case of making all coal gas.

The plant required for an installation to manufacture 200,000 cubic feet of carburetted water gas in 24 hours would consist of a generator, superheater and fixing chamber, washer, oil-heater, seal pot, scrubber and condenser, relief-valves, automatic regulator, hot-air valves, and all necessary connections between the apparatus. An elevated iron operating floor and staircase, and a lift for raising the coke for the generator to the operating floor would also be required. The whole of this plant can be conveniently arranged on a floor-space of about 18 ft. by 35 ft.; and, if duplicated, the requisite area would be about 30 ft. by 35 ft. In addition to this, there would be one engine of 18 indicated horse power, with special gas-plant blower, an oil-pump and meter for measuring the oil used, a storage tank and tar-separator and tar-pump, and two boilers of about 30-horse power, which are also available for generating steam for the exhausting plant. The buildings, in the case of my own works, would have cost about £700; and the total cost of the installation so far would have been about £3500.

As the production of the gas is intermittent, and is at times very rapid, it is necessary to provide a relief holder, which receives the gas, and acts simply as a governor to keep steady pressure on the exhauster inlet, and allow the exhauster to be run at a constant speed. This relief holder, if erected specially for the purpose, should be equal to at least one hour's production of gas. Having exhausters and engines in duplicate, and purifiers of ample capacity, I could, with my present plant, have dealt with both descriptions of gas, which would have been mixed together at the outlet of the exhausters, and then passed along through the several stages of purification, and through the station meter to the gasholder.

I have already stated that the cost of the plant, as described, would be about £3500; and this amount represents as nearly as possible the value of a gasholder and tank of 120,000 cubic feet capacity, such as we have in use, and from which about 110,000 cubic feet could be taken to supply the consumers. As the carburetted water-gas plant will easily supply (say) 100,000 cubic feet of gas in twelve hours, and would in emergency supply 200,000 cubic feet per diem, it appears that a gas company of this size with a growing consumption, may obtain more benefit by an expenditure of £4000 upon water-gas plant than upon storage. The makers of the plant say that 20-candle gas may be made at about the same price as 15-candle coal gas. As I did not require gas of more than 17-candle power, I made inquiries in various directions, and obtained statistics from which I prepared the following estimate:—

Cost per 1000 *Feet of Making Carburetted Water Gas, Continuous Working, Producing* 100,000 *Cubic Feet in Twelve Hours.*

Coke, used in generator and boiler, 48 lbs., at 12s. per ton	3·04d.
Oil, allowing ·15 gallon per candle power = 2·5 gallon, at 4d.	9·60
Water	0·50
Purification	0·50
Wear and tear	0·50
Labour, 1 man at 5s., 1 youth at 3s. 4d.	1·00
	15·14
Less residual oil	0·14
Cost per 1000 cubic feet for 17-candle gas in holder	15·00

In this estimate, I have placed coke at a price that I should like to realize as an average, and oil also at a high figure per gallon. It is quite possible that the makers of this description of plant may consider that I have not done them justice in allowing such high prices for coke and oil, or in restricting myself to such a low-grade gas as 17-candles, and to so small a daily production as 100,000 cubic feet. But these were the particular requirements in my own case; and I therefore endeavoured to obtain figures that would be realized in practice. In producing gas of the quality named, and up to the stage of manufacture described, I could not put together figures that would show a saving of more than 1d. or 1½d. on the cost of coal gas; but there are other advantages not readily expressed in fractional parts of shillings or pence, that would assuredly result in the saving of pounds.

It would be a difficult matter to show by figures how the cost of producing coal gas was affected by the deficiency or otherwise of storage or gasholder capacity; yet every maker of gas knows that this is one of the principal factors in the case. And it is equally difficult to express in commercial terms all the advantages that may accrue from the judicious use of a carburetted water-gas plant, in conjunction with the ordinary gas plant, although these advantages are in suitable cases perfectly apparent. In towns which are not adjacent to the coalfields, the system described will prove of great service in cheapening the production of gas, and so benefit the consumer, and add to the stability of gas companies; and it is to be hoped that the Committee who are engaged in considering this subject will not impose restrictions that will retard the use of this particular gas when mixed with coal gas in reasonable proportion.

I think that the Directors and shareholders of this Company, as well as the gas consumers, have all cause for satisfaction with what has already been done, when it is remembered that since the opening of the works in 1892 three reductions have been made in the price charged for gas, amounting in all to 7d. per 1000 cubic feet. Compared with the price that was current five years ago, this means a saving to the users of gas in the Company's district of nearly £1200 per annum; and if the reductions result in a proportionate increase of business, I shall hope in time to see the price reduced to 3s. 4d.; and the saving to the town will then amount to not less than £2000 annually.

It may perhaps be thought that the foregoing remarks upon the past and prospective outlay upon the works in question are somewhat irrelevant, as addressed to a body of gas managers; but they serve to show that even a large expenditure of capital is justifiable, when made for purposes that will effect a continued saving in labour, and be productive of improved results in working. The increase of business that I have mentioned as desirable, may fairly be anticipated, for the decreased price multiplies the uses to which gas may be applied for domestic or trade purposes. Engines may be used for sawing wood, turning lathes, pumping water, cutting chaff or sausage meat, or even for driving a dynamo for the production of electric light. It is a matter of indifference to a gas maker whether the gas he produces is used directly for illumination or as the motive power for producing electric light.

As an indication of the increasing use of gas-engines, I may mention an instance that has recently come under my notice. A gentleman was telling me of some work he had in hand in connection with some extensive pumping arrangements for emptying a dock. The object in view was to put down plant that would pump the water out of the dock as quickly as possible, at a reasonable cost, and that would occupy but little space. I suggested the use of gas as the motive power in place of steam; and inquiries put to engineers who have made this class of work a speciality, resulted in the preparation and execution of the following scheme:—

Specification of Plant for Emptying a Dock 450 *feet long, with a mean breadth of* 65 *feet, and* 25 *feet depth of water, containing a ship of* 4000 *tons displacement.*

Scheme No. 1 provided for three 50-horse power nominal gas-engines, each coupled direct to a centrifugal pump for 26-inch suction and delivery, and fitted with disc 5 ft. 4 in. diameter, and mounted on mild steel shaft 7 inches diameter at smallest part. These pumps would empty the dock in 1½ hours, with a consumption of 8000 cubic feet of gas. Speed of engines, 120 to 160 revolutions per minute, to suit head of water. Leakage pump 7-inch centrifugal, driven by belt by 7-horse power nominal gas-engine. This was to deal with the water that would percolate through the dock gates, sluices, &c., after the main body of water was pumped out. Water-tank, 50 ft. by 8 ft. by 4 ft. 6 in., to hold 50 tons of water for cooling the cylinders of the engines.

Scheme No. 2 provided for the supply of two gas-engines, each 96 brake horse power, coupled to two centrifugal pumps with 26-inch suction and delivery, with disc 4 ft. 3 in. diameter, running at 200 revolutions per minute. One 10-inch leakage pump, with disc 3 ft. 6 in. diameter, running at 250 revolutions per minute, coupled to a 9-horse power nominal gas-engine. Tank for water, 38 ft. by 7 ft. by 4 ft. The two 26-inch pumps and the 10-inch pumps would empty the dock, as before described, in two hours. Each of the 26-inch pumps would deliver 1760 cubic feet per minute on the average; and the 10-inch pump, 260 cubic feet. The weight of water lifted in two hours would be 12,600 tons; and the consumption of gas for the purpose, as in the former scheme, would be 8000 cubic feet. The size of gas-main required, if not very long, would be 7 inches diameter. The delivery-main from the pumps would be 40 inches diameter. The size of the house required for the engines and pumps was 50 feet long by 28 feet wide. It was suggested to sink this below the level of the ground, so as to reduce the length of the suction-pipe to 16 feet; and, if desired, the space above the house could be utilized for other purposes.

The engines ultimately adopted varied somewhat from each specification; but the leading particulars of the engines, the results of the tests to which they were subjected, and the diagrams taken, were as shown. [See next page.]

The matter of cost I do not propose to deal with as it does not affect the value of the information so much as the description of the plant; and to myself it was of interest to find that gas-engines could be successfully applied to such important work. The makers recommended the use of producer gas for general purposes, but not in this particular case. The work being intermittent in character, and time being a special feature of the scheme, they pointed out that the work could be done with town gas, while producer gas was being prepared.

Gas has been proved in the workshop to be most handy and cleanly for brazing and enamelling; for heating irons for tinmen, coppersmiths, tailors, and hatters; for painters' use in removing paint; for coffee roasting; and for numberless other purposes. The intensity of heat that may be obtained—either concentrated or diffused—and the ease with which it may be controlled, make it a most valuable aid to the work of the skilled mechanic or chemist. In such a town as Romford, where factories at present are not predominant, we look more to domestic appliances such as cookers, grillers, bath-heaters, and heating-stoves as a means of increasing our business; and the letting of these several articles on hire, coupled with the

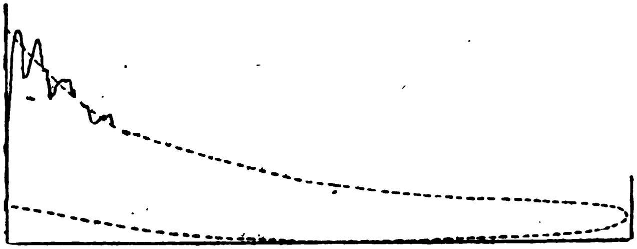

FIG. 20.—DIAGRAM, 40-HORSE POWER (NOMINAL) ENGINE.

Cylinder, 18½ inches diameter.
„ 24-inch stroke.
190 Revolutions per Minute.
Mean Pressure in Cylinder, 89 lbs.
Indicated Horse Power, 137.

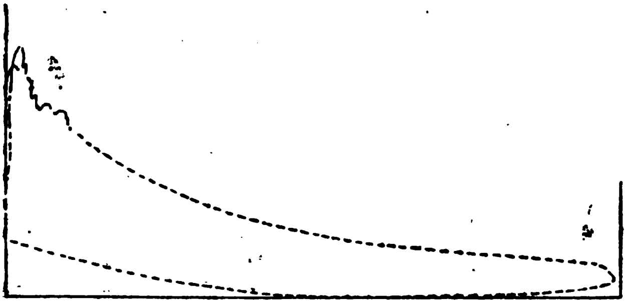

FIG. 21.—DIAGRAM, 16-HORSE POWER (NOMINAL) ENGINE.

Cylinder, 11½ inches diameter.
„ 24-inch stroke.
210 Revolutions per Minute.
Mean Pressure in Cylinder, 92 lbs.
Indicated Horse Power, 60·75.

extension of the prepayment meter system, has placed them within the reach of every mechanic, and added to the comfort of many homes.

I was not at first impressed with the idea that the prepayment meter system and the free fitting of houses, would prove suitable to this particular district, and only entered upon this class of business at the express request of my Directors. As anticipated by myself, the annual consumption of gas per meter in this town has not averaged so high as in many other places; but the returns are sufficiently good to determine it a successful system. At the outset, we endeavoured to frame regulations as to the number of lights, &c., that should be fitted in any house; and were inclined to limit the supply to about three lights and a boiling-stove. We find, however, that personal inspection of each house, and a study of the requirements of the individual, is better than adopting a hard-and-fast line. If a light is asked for in a particular place, and reason given why it is required, then by all means fix it. The service and meter constitute the principal part of the outlay on each house; and the addition of a bracket or pendant means only 2s. or 3s. extra. Even acting liberally in this way, expenditure has been kept within reasonable limits; the average cost of fitting per house being £4 10s.

One other point in this connection. We supply a boiling-burner or griller free; but if a larger cooking-stove is asked for, we require a rental. If we could feel sure that the cooker asked for was required for use, and not in imitation of a neighbour already possessed of a similar appliance, no rental would be necessary; and the best possible proof that it really is wanted for use, is the fact that the gas consumer is ready either to pay a few shillings for fitting, or else a small quarterly rental for the stove.

This subject has been before the Association on several occasions; but I do not think it has yet received sufficient attention. A paper dealing with all the details of obtaining customers, fitting houses, and especially with the best methods of collection and book-keeping, would be of great service. Some companies deal with collection as rapidly as possible—simply putting the contents of each money-box into a separate bag, labelled for identification, and then completing the work in the office. Some even go so far as to ignore any question of shorts or overs; contenting themselves with the idea that one about balances the other, and therefore the company do not suffer. This system is manifestly unfair; and it may be compared, with insufficient attention to the accuracy of measurement, with ordinary meters. Any such irregularities are certain to be discussed between the consumers, and give rise to dissatisfaction; and therefore they demand the closest attention from companies' officials.

My own system is to have the work done by a competent and trustworthy collector, who reads the meter and prepares the account before the money-box is opened in the presence of the consumer. He says: "You have used so much gas; I require so much money." Any discrepancy between the account and the amount deposited is at once dealt with, and a feeling of confidence established between the consumer and the Company. In two years, we have only had one case in which the consumer declined to pay an amount asked for shortage; and this unfortunately occurred at the first collection of this particular account. As payment was positively refused, the meter was removed, and the account closed. We have only a few consumers on this system; but the statistics may be useful.

Houses supplied with prepayment meters and fittings		140
„ „ with prepayment meters only		22
Outlay on meters	£320 5 6	
„ on fittings	310 0 7	
		£630 6 1
Average outlay per house for meter and fittings		4 10 0
„ consumption per meter per annum		8650 cubic feet
Total annual consumption of gas		1,210,200 „ „
„ „ collection, including stove-rents		£340 0 0
Cost of clerical work and collection, six times annually		16 4 0

I expect improvement in each of these details, for the following reasons: First, that we have certainly a much better class of consumer waiting to be supplied than have yet been dealt with, and from whom we may expect a larger annual consumption; and, secondly, that the work of collection will be carried on at a decreased rate per house as the number of consumers is added to. At present, they are scattered over a wide area; no restrictions having been imposed, nor any attempt made to confine the system to any particular district.

One other benefit to be derived from the use of the prepayment system, is the reduction in the number of bad debts. In the case of new and doubtful customers, I invariably suggest the use of a prepayment meter, and find it easier to obtain the money in this way than by demanding a deposit as security, in addition to which we save the 5 per cent. we are compelled to pay on the amount deposited. Persons of limited means starting in business, who really require all their money as working capital, are in this way enabled to obtain a supply of gas, and are at no time inconvenienced by the presentation of a heavy account for payment.

It may be within your recollection that at one of our recent meetings the Chairman of the Company then visited requested some member of the Association to prepare and read a paper furnishing information relative to the working of the sliding-scale and the apportionment of profits to reducing the price of gas and the raising of dividends above statutory rates. It is a point that cannot be said to come within the range of the engineer, but is distinctly a matter of administration of the company's business by the directors. It is, moreover, a delicate subject to handle without creating offence; and it must therefore be distinctly understood that the remarks made have no application to any particular company, but are merely general expressions of opinion.

The Metropolitan Gas Companies—acting presumably upon the idea that their affairs have been closely scrutinized for the purpose of determining the actual value of gas in the districts supplied, before the initial price was given—have availed themselves of the powers conferred by their Acts of Parliament, and have taken for the shareholders a considerable portion of the increased dividend to which the sliding-scale entitled them. The procedure of most Provincial Companies in this matter has been very guarded, and rightly so.

An examination of the Parliamentary Returns shows that, at all events in the case of provincial undertakings working under Provisional Orders, the Board of Trade usually exercise a fairly liberal spirit in fixing the initial price for companies applying for powers. After due inquiry into the value of material and labour in the particular district, and any special circumstances attached to the company's working, the Board only impose such conditions of price and quality as are likely, with proper care and management, to result in the maintenance of profits up to the amount required for payment of statutory dividends, and leave such a margin as to place the company in a safe position.

Taking this into consideration, it does not appear prudent that any company working under such conditions should avail themselves of the first favourable opportunity of lowering the price of gas to increase the dividends above the statutory rate, especially if the increased profit has been obtained under conditions that did not exist when the initial price was fixed. The directors of such a company should first assure themselves that their works are ample in capacity, and in thorough working order to fulfil all the obligations they have undertaken. If the contrary is the case, and any considerable outlay is required, they may still be able, with advantage to the company, to lower the price of gas without paying a higher rate of dividend, owing to the increased amount of capital. They should feel certain that they are supplying gas at as low a rate as the circumstances of the district will permit, which may be judged to some extent by a comparison with adjoining companies; and also that the price charged for gas will not prove a hindrance to any particular class of business. In order to encourage the use of gas-engines or other trade appliances, it may even be advisable to adopt a differential rate for gas, in order that the price charged may be sufficiently low to compete with rival methods; though users of motive power are daily recognizing that there are many advantages attending the use of gas beyond what can be discovered by any calculation of the difference in the value of coal when converted into gas or employed for the purpose of raising steam.

Care should be exercised in the case of alteration, replacement, enlargement, or extensions of plant or mains, that the proper amount only is charged to capital account. Plant once provided out of capital must have its representative value. Replacements or renewals may be charged to revenue; and additions, or the actual increase in value due to enlargements, may be placed to capital account. Care should also be taken, before raising the rate of dividend, that, unless from some unforeseen labour strike, accident, or some other misfortune, no necessity should occur for going backward, or, except for some very special reason, for using a reserve fund to maintain dividends, which should be fairly earned in the year's working.

Having safeguarded themselves on these and any further points that may commend themselves to the directors of the undertaking, it appears perfectly legitimate that the shareholders who have placed the conduct of their affairs in the hands of gentlemen possessed of business capacity combined with prudence, should be permitted to participate to a limited extent in the results of their successful business methods.

A company about to raise additional capital for some extraordinary expenditure, may be inclined to raise their rate of dividend in the hope of obtaining a higher price for the shares, and consequent larger amount of premium capital; but this can only be considered bad policy. Shares are constantly changing hands, and may have so high a rate of dividend quoted as to raise dissatisfaction in the mind of every user of gas, and yet yield the investor but a very moderate return on his outlay; and unless the rate of dividend at the time of purchase is maintained, the investor is likely to make as great an outcry as any dissatisfied consumer. The sliding-scale is based upon equitable principles; but it is certain that it requires to be used with caution and judgment, if the effects of its working are to have a lasting value.

It is unusual for any discussion to take place upon the President's Address, though why this should be so I am at a loss to explain. Statements not open to challenge cannot be generally accepted; and therefore under existing conditions presidential addresses can have but little value. Unless the Association is better supplied with papers at our next meeting than on the present occasion, the members are at liberty, if they think it desirable, to discuss any point that I have raised, if they will be good enough to notify their intention to the Secretary. In this way, we may very possibly raise some debate useful alike to the Association and to your President.

Mr. J. Carter (Lincoln) said it was his pleasure and privilege to ask the members to express their appreciation of the service the President had rendered to them by the preparation and reading of his address. It was an unwritten law of their gatherings, as they had been reminded, that the utterances of the President in his address were safe from criticism; and, in this particular instance, it was perhaps as well for the members that they were, because he was not certain that any of them would be guilty of the audacity that was requisite to criticize any statement emanating from the gentleman who now occupied the chair. They all expected of Mr. Child a deliverance that would deal, with care and intelligence, with matters of interest in connection with the manufacture and supply of gas; and he ventured to say that, having listened to his remarks, none of the members were disappointed.

Mr. J. Barton (Peterborough) seconded the motion. He said the address contained points of interest that would be worth reading again and again.

The President, in reply, said he could only thank the members for listening so attentively to what he had prepared.

Mr. H. Wimhurst then read the following paper on

THE WORKMEN'S COMPENSATION ACT, 1897.

The Workmen's Compensation Act of 1897, which came into operation on July 1 is of no little moment to gas managers, whether engaged on large or on small works. It will press very unduly upon the smaller; they being less able to bear any great and sudden charge upon them which the Act entails. Therefore the question one naturally asks himself is, how best to prevent uncalled-for expense on the revenue of the undertaking. In my opinion, there are only two ways out of the difficulty—either create and maintain an insurance fund by the placing aside of a certain sum annually out of the profits of the undertaking, which sum can be readily ascertained by past experience in this direction, *plus* a percentage for the extra risk entailed under the Act; or (and to my mind much the better and safer plan for small works, with less than an annual wage payment of £6000) to secure oneself with a perfectly good and sound Insurance Company, even if the premium is a few shillings per cent. more than some other and less sound offices are asking.

When we consider the amount of risk the offices run of actions at Common Law, under the Employers' Liability Act, and, lastly, under the Workmen's Compensation Act, 1897, I do not think the reliable offices are asking too great a premium rate from gas undertakings when it is not more than from 8s. to 10s. per cent. upon the amount of the annual wages paid. We may also consider that the rates as at present fixed are merely experimental, and will in the near future be greatly reduced, when the offices see that the risk entailed upon them by gas-works insurance is much less than they anticipated, though the Act will certainly make workmen much less careful in following their daily occupation.

There is already an indication to amend the Act, at the instance of the Parliamentary Committee of the Trades Union Congress; and a no less authority than Mr. Asquith has indicated his general approval of it in a letter to Mr. S. Woods, M.P. The amendments, as drafted by this body, are: Provision for the payment of the first two weeks' injury; abolishment of the doctrine of common employment; and provision against contracting out. It also abolishes the principle of contributory negligence, and provides for injury to health. Should the Act be thus amended, our expenditure under this head will have a tendency to increase rather than diminish.

I should gladly welcome a federation of the Incorporated Gas Institute and the Institution of Gas Engineers with the District Associations, in order to form an Insurance Corporation for the insurance of gas undertakings under the Workmen's Compensation Act of 1897. With the London offices and staff of the two Institutions, one cannot conceive any great difficulty in this direction, especially if the Councils of the two societies could arrange for an early amalgamation of their bodies. If such an Insurance Corporation could be formed, I have no doubt it would meet with the approval and support of all gas-works officials. Such an united Association could obtain a very low premium rate from the sound Insurance Companies, very much to the benefit of all the insurers.

The North of England Gas Managers' Association, with their efforts in this direction, have been enabled to insure at 9s. 6d. per cent. to the extent of £120,000 annual wage payment, spread over 40 works. If this can be accomplished with 40, what could be obtained by the amalgamating of 400 to 600 works for such a purpose? The answer would probably be, a premium rate of 5s. to 6s. per cent. Surely, then, this subject needs our active and immediate attention, so as to bring about such a desirable result.

Discussion.

Mr. J. Carter (Lincoln), called upon to open the discussion, said he was not quite certain that he had any definite opinions on the question dealt with by Mr. Wimhurst. He was almost as much pleased with the omissions of the paper as with the actual statements. He was glad that the author had not given himself over to anything like a wild denunciation of the Workmen's Compensation Act, which had been received with very mixed feelings in all industrial circles. He (Mr. Carter) thought that any legislation that imposed upon employers of labour the utmost care in the conditions under which workmen had to do their daily toil, and which placed upon the employers the full financial responsibility for accidents, ought to be received without any very violent feelings of dissent. It should first of all be their earnest endeavour to carry out what he took to be the primary object of such legislation—that was to say, everything should be so arranged that the liability to accident should be reduced to a minimum. He must confess that it was rather distasteful to him to discuss a subject like this in any way, when looked at from one point of view. He did not like to talk upon the question of workmen's lives and limbs in connection with *£ s. d.* He did think above everything else their first object should be to preserve their workmen from accident. His own opinion was that a great deal too much had been said about this question. They were, he supposed, now passing through an experimental or transitional state. The Act was quite new; and the insurance companies scarcely knew how high the terms should be which they ought to impose upon insurers. The question of how low they should be, never seemed to have entered their heads at all. He thought they might wait to see the course of events during the next twelve months; and probably by that time rates would be quoted by all the insurance companies which would be far more moderate and reasonable than any they had yet heard of.

Mr. JOHN WEST (Manchester), on the invitation of the President, said the question dealt with in the paper affected a large number of manufacturers perhaps more than it did the proprietors of gas-works. It might be interesting if he explained what the manufacturers had been doing in the Manchester district. They considered the new Act was very oppressive upon the capitalist; and while they desired to protect the lives of every workman, as well as their own (because the employers were as liable to accident as the workmen), they thought they should not be called upon to pay when men, through carelessness, contributed to any accident, as was often the case. Many years ago, the Iron Trades and Engineers' Association in Manchester insured themselves among themselves; and it had been a very fortunate thing for them that they had kept statistics showing, upon the average, which classes of men were more liable to accident than others. They had gained experience which clearly showed that men might be more liable to accident in one particular branch of engineering than in others; so that, when the new Act was forced upon them, they pretty well knew the position they were in, with the exception of the unknown quantity—the contributory accidents which so frequently occurred. The manufacturers considered the course they should take under the new Act; and they decided to assess themselves at the rate of 9s. per cent., and so insure themselves. The accidents had been very small matters. The same office that looked after the other affairs of the Association attended to this insurance business also; and the advantage the manufacturers had secured was this: Instead of paying to an insurance company (who really did not know what they were about, seeing that the matter was, as Mr. Carter had put it, still in an experimental stage), they assessed themselves at a figure which was about double what was necessary. But, at the same time, they made up their minds that they would increase their capital to a very considerable extent, so that they would be prepared to meet any emergency. Therefore, if they had made a mistake in assessing themselves at such a high figure as the 9s. per cent., it would increase their capital, and then, when it reached a certain point (which had been decided upon), they would reduce the rate of payment. The effect of this arrangement, which had been carried out for many years in the Manchester district, was that the whole of the engineers connected with the great Federation that was formed during the strike in the engineering trade had joined the Association. They had discussed whether or not they would ask an insurance office to take part of their risk; but they decided that they were powerful enough to take the entire risk upon themselves. He thought the gas companies might very well follow on the same lines, which he was glad to see was suggested by Mr. Wimhurst. Under the new Act, they found men claiming immediately the least accident occurred to them; and he was sorry to say some of the claims were of a very doubtful character—indeed, a large number of the men were only "on" for a few weeks. There was no doubt the Act had not been well considered; and, while Mr. Woods and Mr. Asquith might have something to say in favour of amending the Act in the way indicated in the paper, he was glad that the Association to which he had referred was strong enough to claim a hearing in connection with any propósal to make a change. It was the desire of all fair-minded employers to meet reasonable demands arising from any legitimate accident that might occur on their works; but he did not think it right that they should be called upon to compensate men for any accident arising from drunkenness, semi-drunkenness, or carelessness, which, he was sorry to say, had already occurred. All employers should have such an amount laid by as would enable them to pay for accidents that occurred legitimately, and the amount should be a tax upon the public by charging more for their wares. He thought the gas industry might with advantage follow the example of the Engineers' Federation. It had been suggested that gas undertakings should insure in insurance offices; and as they had few cases of accidents, perhaps it would be as well. At the same time, he did not see why The Gas Institute should not do as the engineers had done, because the old insurance people were simply protecting themselves by asking exorbitant premiums. They were bound to ask for something large, seeing that they did not know what the Act would bring about. He was decidedly of opinion that gas companies might form an ample insurance fund among themselves.

Mr. J. H. TROUGHTON (Newmarket) said that some six years ago his Company somewhat anticipated the Workmen's Compensation Act by insuring their men against accident under the old Employers' Liability Act, actions at common law, and also for half pay in the event of men being incapacitated through accidents. They paid a premium of 15s. per cent. for these benefits, which they had enjoyed for six years, during which time they had paid about £70 altogether in premiums. In this period, they had only had six very slight accidents; and the amount of compensation received from the insurance company totalled £14, or exactly 3s. per cent. on the wages paid. When the Workmen's Compensation Act came into operation, they wrote to the insurance company to know how much extra would be required for the additional risk. They were quoted a premium of 25s., which, of course, his Directors refused; and they also decided not to insure again for a time, seeing that they had a small insurance fund upon which they could draw in the event of any claim being made upon them. Since then, the rates of the insurance companies had been very materially reduced; and only the previous day he signed a proposal form to insure the workmen for full benefits under the Act at 9s. per cent. Consequently, instead of paying 15s. under the old Act, they were insuring for less money against additional risks. He did not think that 9s. per cent. on the wages paid was by any means unreasonable. They had simply decided to insure for one year or longer as was thought desirable; but in the event of The Gas Institute formulating a scheme by which gas companies could amalgamate and insure at a cheaper rate, of course his Company would join.

Mr. J. W. HELPS (Croydon), invited to take part in the discussion, said his Company anticipated some such legislation as the Workmen's Compensation Act several years ago. Twelve or thirteen years since, they started a fund which they called their Sick and Burial Fund; and among the rules of the fund was one which allowed the Engineer, at his discretion, to pay any man who met with an accident during the discharge of his duties a sum not exceeding two-thirds of his weekly wages at the time the accident happened. During the twelve years, they had kept a careful record of the amounts expended, especially those under the head of accidents; and when he had to report to his Directors on the subject of insurance, he took the figures out. He found that, during the twelve years, they had paid in wages something like £180,000; while they had only spent £140 in compensating the men who had met with accidents for the time they lost. It might be said that they were not quite so particular under the rules as they would be under the rules imposed upon them by the Workmen's Compensation Act, because, for instance, supposing a man met with an accident within a couple of days before pay-day, he (Mr. Helps) might have said to the person paying the wages: "Pay him his wages for these two or three days; and then, if he is away next week, put him on the sick fund." But that would be more than compensated for by the clause in the Act which did not compel any company to pay the workman for the first fortnight during which he was suffering from an injury. The matter had been frequently discussed by his Directors; and they were still undecided as to what course they would adopt. He might state that the figures he had quoted worked out to something like 1s. 7d. per cent. By their Private Act, they were given power to form an insurance fund, which now amounted to some thousands of pounds; and he had advised his Directors that he thought they would be perfectly within their rights if they used the fund for the purpose of compensation under the new Act. The clause in their Act giving them the right to establish such a fund was something to this effect: The Company have the power to form an insurance fund, and to use it to meet any claim for any accident that may arise, which accident could not have been prevented by due care and forethought on the part of the Company. Therefore he considered that they might fairly use this money to meet any claim made against them under the new Act. If they could not, what was the fund intended for? His Company had wisely insured their boilers against accident; and they had insured the works against fire. Therefore he did not see what accidents could happen there (save those to men) for which they would have to take money out of the fund. He agreed with a previous speaker, that perhaps too much had been made of the large premiums required by the insurance companies, because they had had to quote without experience of what might happen. At the same time, he could not help thinking that the insurance companies, if they had liked, might have obtained information that would have enabled them to ask lower premiums. It would have saved a lot of trouble and discussion on the subject. The whole question had now been placed in the hands of a well-known actuary; and he was going into the matter. They had given him all the particulars in their power; and no doubt he would be able, with the figures at his disposal, to find out what was a fair percentage on the wages to set aside, and devise some scheme that would be satisfactory to the Company he (Mr. Helps) represented at Croydon.

Mr. E. W. SMITH (Chelmsford) said his Company considered the

Workmen's Compensation Act imposed a great liability upon them; and they met it the only way they could do, by insuring. It would be difficult for him to believe that the insurance companies could not obtain figures upon which they might have worked in deciding the amount of premium they should charge. Surely, since the passing of the old Employers' Liability Act, some records had been kept of the number of accidents that had happened. His Company insured under that Act; but their experience had differed from that of the Newmarket Company. He believed the amount of compensation they had received in the years they had been insured was about equal to what had been paid in the shape of premiums. However, most, if not all, of the accidents that had happened had been very small, and only kept the men away from the works for one or two weeks. This was a point of great importance to them, as a proposal had been made to amend the Act by providing for payment during the first two weeks' injury. In his opinion, the large employers of labour should try to retain the existing clause as long as possible. He very much admired Mr. Carter's fair-mindedness; but personally he could not help thinking that the new Act imposed upon employers a greater responsibility than they ought to be expected to take, inasmuch as accidents were liable to occur over which the employer could have no control or that could be traced to his carelessness or negligence.

Mr. F. PRENTICE (Ipswich) said that the Company with which he was connected had not had very much experience with the insurance companies, as they preferred to take their own risk, whatever it might be. From the experience they had had for a good many years past with their sick fund, they did not think the risk was a grave one, or one they need shrink from. They had a workmen's club, to which the men subscribed 3d. each per week, which entitled them to 10s. per week when they were ill. Any deficiency in the fund was made up by the Directors. Sometimes they were called upon to the extent of £50; at other times the club had money in hand. They had never had any serious disaster such as might lay a number of men low. That perhaps would be rather a serious position to find themselves in. But what he had stated explained the position they were in at present; and, until they saw some reason for altering it, he believed they would continue in the same course—at all events, until the ridiculously high rates of the insurance companies were reduced The Ipswich Company had been quoted 25s. per cent., and then 12s. 6d. per cent., which utterly precluded the idea of insuring in the usual way.

Mr. Smith inquired whether the 9s. per cent. referred to by Mr. Troughton covered accidents during the first two weeks.

Mr. Troughton said he did not think so. The Act provided that the first two weeks should not be paid for. The 9s. covered everything contained in the Act.

Mr. E. W. T. Richmond, responding to a call from the President, said the remarks that fell from Mr. Carter were worthy of careful consideration; and he could quite endorse them. They should all look at this question in a broad spirit. The working man had only his labour to sell. He had no capital, and no resources; and if accident prevented him following his occupation, he had no means of keeping the wolf from the door. In his opinion, the capitalist should readily undertake all the risks. The heavy rates proposed by the insurance companies throughout the country were greatly to blame for the indignation that had been displayed by the great employers of labour; but the Act had been in operation for three months, and the indignation was now simmering down. He saw by the paper that the North of England Gas Managers' Association had been enabled to insure at 9s. 6d. per cent. to the extent of £120,000 annual wages payment, spread over 40 works. His Company had done better; they had a policy for £30,000 at 7s. 6d. per cent. Of course, they were quoted all sorts of rates at the commencement. The first figure was 25s.; then they were quoted lower; and eventually they got down to 6s. 6d. They, however, decided to pay the extra shilling, as they preferred going to an office which they knew had a substantial capital at its back. Taking 7s. 6d. on the wages paid, it did not by any means handicap production in such a way that it need be held up as a bogey. He himself had no fear as to the results that would follow the working of the Act.

The President said it appeared to him perfectly right that the industries of the country should be burdened with the results of accidents that could be properly described as such; but one point that struck him was that there should be some process of inquiry by which it could be determined whether or not the sufferer from an accident brought it upon himself by a wilful act of his own, or by, as Mr. West plainly put it, drunkenness or semi-drunkenness. A man who so brought about an accident, by which he was himself injured, and perhaps property too, should be debarred from becoming a burden on those who employed him. If an accident was unpreventable, any workman injured by it should be compensated by his employers. A gas company would not be the first to withdraw themselves from such an obligation. He believed they would spend any amount of money to render their plant so safe that their men could carry on their work with perfect impunity.

Mr. WIMHURST, in closing the discussion, said he cordially endorsed the remarks made by Mr. West; and he hoped and believed a federation of The Gas Institute and The Institution of Gas Engineers would take place. Then could follow the insurance, under the amalgamated body, of all the gas-works in the kingdom, at a much cheaper rate than they were asked to pay at the present time.

A vote of thanks was passed to Mr. Wimhurst for his paper.

PLACE OF SPRING MEETING.

A conversation followed as to the place of the spring meeting. According to Mr. Wimhurst, some of the distant members had complained of the inaccessibility of Peterborough; and therefore, on his motion, it was resolved to visit Cambridge for the next meeting.

VOTES OF THANKS.

Resolutions were next passed heartily thanking the District Council for the use of the Council-Room, and the President for the manner in which he had conducted the proceedings.

Following the meeting, the visitors, on the invitation of the President, had a pleasant drive in the surrounding country. Shortly after their return to Romford, the members dined together at the White Hart Hotel.

NORTH OF ENGLAND ASSOCIATION.

HALF-YEARLY MEETING, OCT. 1.

This Meeting was held at Sunderland; the rendezvous being the offices of the Gas Company. The President—Mr. CHARLES DRU DRURY, Engineer to the Company—received the members and associates, saw them into conveyances, and drove off with them to the Company's works at Hendon. They are situated on a high bank overlooking the sea, nearly a mile to the south of the town. They were erected in 1863, on a site 17 acres in extent, to designs by the late Mr. Thomas Hawksley, and are of massive design. Everything is on a spacious scale, particularly the outdoor areas separating the various buildings. The visitors were shown round the establishment without reference to the course of manufacture—beginning with the scrubbers, and passing through the purifier-house, the sulphate-house, and the retort-houses, and ending with a stroll round the gasholders. The chief attractions were the steam-boilers on the top of the retort-benches, which Mr. Drury explained to the Association at their meeting in April (*ante*, p. 156), and the sulphate plant, dealt with in his Presidential Address. With regard to the boilers, one, a Cornish, was at work, and the valve was blowing merrily; while another, a Lancashire, was being placed in position. The method of doing this was to sling up the boiler, and then build the bench beneath it.

On returning to the town, the meeting was held in the Boardroom of the Gas Company. Mr. DRURY presided over a crowded gathering. On his right were Mr. J. Stokoe, J.P., the Chairman, and Mr. G. R. Booth, the Vice-Chairman, of the Company.

WELCOME TO THE ASSOCIATION.

Mr. STOKOE said that, as representing the Sunderland Gas Company, he had very great pleasure indeed in giving the Association a hearty welcome to Sunderland. They were glad to see them, especially as Mr. Drury was their President. They were almost disposed to take it as a compliment that Mr. Drury had been elected to this position. He might say that, so far as the Gas Company were concerned, they had had the advantage of the very lengthened service of their Secretary and Manager, Mr. Cox; and their success had been, in his opinion, largely owing to that gentleman's management. They also had the advantage, for several years, of the services of Mr. Jolliffe, who did well for them. He was followed by an exceptionally able and exceedingly modest young man; but Providence did not spare him to them. They then selected Mr. Drury, who had been with them now for several years. They had had no reason to regret their choice; nor did he think Mr. Drury had any reason to do so.

The PRESIDENT begged, on behalf of the Association, to thank Mr. Stokoe very cordially for the particularly friendly welcome he had given to them, and for the very excellent arrangements which had been made for their comfort. He hoped the meeting would be a great success; and, certainly, to the extent which the Sunderland Gas Company had to do with it, he was quite sure that it had already been so. He also desired to thank Mr. Stokoe for his kindly references to himself.

NEW MEMBERS.

The following gentlemen were admitted members of the Association: Mr. J. A. Gray, Cleator Moor; Mr. T. Worfolk, Knottingley; Mr. W. J. Mott, Selby; Mr. J. Eadington, Blyth; and Mr. E. E. J. Anderson, Ripon.

THE LATE MR. R. WALLIS, J.P.

The PRESIDENT said that, before proceeding any further with the business, he wished to express the sorrow which they, as an Association, felt at the death of Mr. Robert Wallis, J.P., Chairman of the South Shields Gas Company, and an ex-President of the Association. Mr. Wallis died at the ripe age of eighty-nine years. He always took an active interest in gas matters. For fifty years he was a Director, and for the last forty years the Chairman, of the South Shields Gas Company. Only once, he understood, was he absent from the annual meetings during the period of his chairmanship. As a man, he was sympathetic and kindly; and he was sure he was one who left this world better than he found it.

WORKMEN'S INSURANCE; STANDARDIZING METER-UNIONS.

The HON. SECRETARY (Mr. J. H. Penney, of South Shields) read the following report of what had been done with regard to insurance under the Workmen's Compensation Act and the standardizing of meter-unions :—

It will be remembered that at our April meeting you determined that this Association should confer with other Associations relative to the Workmen's Compensation Act, with a view to ultimate steps being taken for the formation of some mutual insurance society; and the President and myself were empowered to deal with the matter.

The kindred Associations were communicated with, and asked if they would be willing to join in a conference on the subject, should the Insurance Companies fail to reduce their rates in the meantime. The Incorporated Gas Institute and the Institution of Gas Engineers were also written to; but the replies were not encouraging, except that from the Incorporated Gas Institute. Mr. Dunn, the courteous Secretary of that body, replied that arrangements would probably be made for a paper to be read on the subject at the Belfast meeting. A paper was read at that meeting; a long discussion ensued; and much useful information was elicited.

Your Committee held several meetings in May and June last, when some of the best Insurance Companies were approached with a view to obtain a minimum quotation, with a sliding-scale, for the North of England. Quotations were received, in due course, from tariff and non-tariff offices; but the majority of them were very high. Ultimately, the following sliding-scale quotation from a good and sound office was accepted :—

On wages not	exceeding	£100,000	10s.	0d.	per cent.
,,	,,	150,000	9	6	,,
,,	,,	200 000	9	0	,,
,,	,,	250,000	8	6	,,
,,	,,	300,000	8	0	,,

A circular was afterwards sent to all the Gas Companies and Local Authorities owning gas-works within the area of the Association's district, inviting them to insure under this arrangement; pointing out that "the larger the number of Gas Companies and Local Authorities insuring under this scheme, the lower the premium would be to each."

The result, to this date, has been, that, in round numbers, about forty Gas Companies and Local Authorities have insured up to about £125,000 in wages, at 9s. 6d. per cent.

With regard to the question of the standardizing of meter-unions, at the April meeting of this Association, on the invitation of the North British Association of Gas Managers to join them in trying to get a uniform standard for meter-unions established, you deputed the President and myself to represent this Association at any conference which might be held. We accordingly communicated with the North British Association, advising them that we had been appointed to confer with them, and requesting them to keep us informed of the progress of their deliberations from time to time. We subsequently received a reply, stating that

a paper would be read upon the subject at the Belfast meeting of the Incorporated Gas Institute. A paper was read, and the matter was referred to the Council to consider what steps should be taken. We have not received any further communication on the subject.

The PRESIDENT then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—I beg to thank you for the honour you have conferred upon me in electing me President of this important Association for the current year. Were it not that I have the valued assistance of the Committee, I dare not have undertaken the responsibility; but with their help and your kind forbearance, I trust the interests of the Association will not suffer during my term of office.

I think we may fairly congratulate ourselves on the fact that the North of England Gas Managers' Association has this year attained its majority. It was first formed on the 10th of April, 1877, at South Shields, when our highly-esteemed friend Mr. Warner was elected first President; and the first general meeting was held in Newcastle, on Saturday, Oct. 27, 1877. As a comparatively new member, I trust I may say without undue conceit that we ought to be proud of the high position that this Association holds, and of its firm numerical and financial basis. After a healthy infancy and a vigorous and sturdy youth, it has reached manhood; having I believe suffered very little, if at all, from the complaints and ailments to which childhood is subject, or from the excesses in which youth sometimes indulges. I would not, however, for a moment wish it to be imagined that we, as members, consider no further improvement is either desirable or attainable. Representative as our Association is, there are still professional brethren in its district who have not yet cast in their lot with us; and it should be our duty and privilege to invite them to do so. There is also ample opportunity for all of us, and more particularly the younger members, to make the Association one of increasing usefulness by working for it in many ways—such as contributing papers to be read at the meetings, taking part in the discussions, and generally giving it the benefit of their experiences; and when I say experiences, I mean those of failures as well as those of successes. I must admit that it requires courage to chronicle one's disappointed hopes and abortive actions; but it will be readily conceded that a man who is able to calmly and dispassionately review his errors of judgment or misfortunes, will not rest content until matters are placed on a more satisfactory footing.

Speaking on this important occasion, the 21st anniversary of the first general meeting of the Association, I labour under the great disadvantage of being unable to claim 21 years' personal acquaintance with gas manufacture. I cannot therefore rely on my own observations in comparing the condition of things then and now. Thanks, however, to an excellent technical press, this defect can to a certain extent be overcome.

Looking back upon the period named, one thing, I think, is certain—viz., that among gases coal gas continues to hold the field as an illuminant and heating agent. In this country, at any rate, gases made from other substances than coal serve only as hand-maids to their mistress coal gas. Carburetted water gas and oil gas, useful as they no doubt are as auxiliaries and enrichers, are relegated to a very secondary position in the economy of gas manufacture. Continuing the retrospection still farther, one cannot help being struck, when considering the process of manufacturing coal gas, at the remarkably able manner in which the pioneers of our industry laid their plans and designed their apparatus; and glancing backward over the period of this Association's existence only—a period which perhaps has never been surpassed for fertile imagination, for inventive genius, and for the harnessing of Nature's forces for the service of mankind—is it not wonderful that, in their essence, the production, purification, storage, and distribution of coal gas have not undergone any fundamental change? Improvements in details there have, of course, been; but the methods remain the same. Broadly speaking, all economies effected have been obtained by means of improved methods of handling material—such as machine stoking, inclined retorts, conveying machinery, and labour-saving appliances generally. Unfortunately, all the genius of the gas profession during the past 21 years has not yet satisfactorily disposed of two great annoyances to which gas managers are subjected—I mean stopped ascension-pipes and naphthalene deposition—and that these two matters are a source of endless worry and bother, few will be inclined to dispute. I know, of course, that cures for stopped pipes have been tried and found more or less successful in certain cases, and that the formation of naphthalene can be prevented by the use of oil vapours. But do these remedies in either instance go to the root of the matter? I fear not.

Turning to the efficiency of coal gas as an illuminant, what a revolution in the candle duty has been brought about in the last two decades—or, as a matter of fact, in far less time than that. Who among us, even a few years ago, would have ventured to prophesy a duty of nearly 30 candles per cubic foot of gas for burners consuming as little as ¾ cubic foot per hour, and upwards? To Dr. Auer von Welsbach the gas industry owes an incalculable debt of gratitude; and may we hope the gratitude is of that quality which conveys a lively sense of favours to come in the shape of a more robust mantle.

Here perhaps I may be allowed to touch a weak point in our methods, and one which it is high time that we remedied. I refer to the supineness of gas undertakings in popularizing the use of gas. Are not consumers left to themselves far too much in the application of gas as an illuminant and heating agent? Do not they (the consumers), through ignorance or want of thought, squander the wealth of hydrocarbons contained in their supply of gas by the use of ancient and unprofitable burners, niggardly service-pipes, and badly-arranged fittings? Where are the officials appointed by the gas undertakings whose duties it should be to educate the popular mind on these subjects? I am afraid in the very large majority of cases, echo still answers "Where?"

Twenty-one years ago, electric light was just beginning to make itself felt as a force to be reckoned with; and everyone remembers the scare produced among gas shareholders about that time. Prophecies were heard on all sides that the reign of gas was over, and that it, and all its works, would very soon be relegated to the limbo of oblivion. Time, as less hasty judgments foresaw, has proved otherwise; and the electric light, with all its improvements and cheapened production, has not yet ousted us from our position. There is a vast and ever-increasing field for both commodities; and the electric light, though not to be despised or underrated as a rival, is not feared, but rather welcomed as a pioneer of improved lighting, and a creator of a desire for yet more light.

The past twelve months have not been devoid of topics of exceptional interest to us. A year of great national commercial prosperity, the cost of raw materials has naturally gone up by leaps and bounds. Manufacturers of gas, however, feel the bad effects of such general prosperity; for coals, iron, bricks, and labour are dear, and very often bad at the price, and, except in districts containing an unusually large proportion of factories and workshops, there is no commensurate increase in the consumption of gas. Very few householders or shopkeepers burn less gas because times are bad or more because they are good.

As I have said, the general tendency of prosperous times is to send prices up; but in the matter of gas our interests are all the other way. Unfortunately, we are beginning to associate good times with labour troubles; and, though now both have happily terminated in peace, it will be many years before the disastrous effects of the great engineers' strike and of the Welsh coal strike cease to be felt. So much interest has been centred in these two industrial wars, that it would be only waste of time for me to mention any of the details connected with them. But when one realizes the time wasted—seven months in one case, and five in the other—and also the immense sums of money lost to the community at large, one is appalled. In the case of the coal strike, I saw it mentioned a few days ago that the ascertainable loss due to it was estimated at £7,000,000.

Most of us will have asked ourselves what is the remedy for these suicidal misunderstandings. Is the prosperity of the country to be imperilled and wasteful strikes and lock-outs indulged in right up to the close of this so-called enlightened nineteenth century? Of one thing, however, I feel sure, and that is the absolute futility of compulsory State intervention, for which, in crises like those mentioned, certain sections of the public are so ready to clamour. Whatever might be done in Germany and in other semi-despotically ruled countries, no Government in our country will be able to compel a man to sell his labour for any less price than he may think fit to put upon it, or, on the other hand, to force an employer to pay more for labour than he can afford to do, or to run his business at a loss. No; in my opinion there must be a better understanding between employer and employed before disputes can be settled in a more satisfactory manner. There appears to be a want of confidence between labour and capital—the men mistrust the masters and the masters the men.

Workmen, as a rule, have no interest in a business beyond getting as much out of it as they can with as little effort as possible; and increased energy on their part does not, directly at any rate, bring them any advantage. Surely, then, if this be the case, the cure for strikes lies in the direction of co-operation in some form or another. Under this system, employer and employed have the same interests, and will pull together instead of against one another. In so doing the mutual confidence, which is now so lamentably deficient, will be restored, and disputes (if any) arising will be amicably settled. Fortunately we are not left entirely to speculate on what the results of such a cure would likely be. We have many examples of co-operation around us; and one especially interesting to us, in the form of profit-sharing, is to be seen in the case of the South Metropolitan Gas Company, of London, where, under the fostering care of Mr. George Livesey, its success is beyond all doubt. We shall watch with interest the result of the latest development of the South Metropolitan scheme—the Workman Director. This move appears to be the logical conclusion of the system; but the carrying out of the idea presents many difficulties.

A great deal has been written and said of the probable effect on the industries in this country of the Workmen's Compensation Act, which came into force on the 1st of July last; but there is no doubt that the disastrous results which in many quarters were predicted have been found to be very much exaggerated. Mr. Chamberlain stated that the principles of the Act were: That every workman is entitled of right to moderate and reasonable compensation for all accidents happening to him in the course of his employment, unless caused by his wilful default; that this compensation should be a charge upon the employment in which the accident occurs; and that it is not a fine upon the employer, but a recognition of the just claim of the workman. Many people insist that the tendency of the Act is distinctly socialistic; but, as Lord Salisbury observed in the House of Lords, it was the late system that was socialistic, inasmuch as it threw upon the rates the charge of maintaining the sufferers from industrial accidents. In any case, few will deny the justice of making reparation to a workman who, while in the pursuit of his calling, meets with a serious accident—thereby, at one stroke perhaps, losing possibly the whole of his capital, invested as it is in health, muscle, and activity. Manufacturers who use machinery must be prepared to make good any defect which may arise in it or mishap which may occur to it through neglect or some unforeseen cause; and, in the same way, I think this Act provides for accidents to the flesh and blood machines to which we owe so much. The passing of the Act produced something akin to a panic in many of the centres of commerce in this country, notably in the coal and iron trades; but, to show that such a state of things was not warranted, I may perhaps be allowed to quote from an article in "The Times" of Aug. 12 last. It says:

> The arrangements which colliery owners have already made, either mutually *inter se* or by insurance with public companies, have justified the belief that a penny per ton all round will be likely to fully meet the provisions of the Act; and this sum applied to the whole coal industry of the country will work out to an annual expenditure of £840,000.

Now in some districts the provision already made for meeting accidents, &c., is so considerable that this burden, if merged in that already borne, will not be nearly so serious as it would otherwise have appeared to be. It was, at one time, anticipated that the Compensation Act would add about sixpence per ton to the cost of producing pig iron; and it was grimly prophesied that this last straw on the top of dearer minerals and foreign competition would completely break the camel's back. Fourpence of the amount stated was expected to be added through the increased cost of coal; and the other twopence was expected to take the form of insurance premiums for the pig-iron industry itself. It now turns out that some districts have been able to effect insurance with public companies at as low a rate as one halfpenny per ton of pig iron produced, and that the increased charge made through coal does not exceed another three-halfpence; so that twopence per ton of pig is an outside figure—being one-third or less of the amount originally talked about. It comes in short to this—that the Compensation Act of 1897, like the Employers' Liability Act of 1880, has been much less harmful to our great industries than was expected.

In our own case, alarm was felt at the almost invariable quotation by the Insurance Companies of a 25s. per cent. rate for gas-works; but, thanks no doubt in a large measure to the action of this Association on the initiative of Mr. Bower, any gas undertaking may through it obtain relief from the risk and annoyance of the Act on the payment of an annual premium of not more than 9s. 6d. per cent. on their wages bill. All the larger gas undertakings, however, will probably be justified in taking their own risk; in which case Mr. Chamberlain's estimate of 5s. per cent. will possibly be found to be over, rather than under, the mark. One cannot blame the Insurance Companies for looking after themselves, especially where the risk is to a great extent a very uncertain quantity. But they will probably have themselves discovered by this time that the chances of accident in gas-works are much less than those in iron-works, ship-yards, &c.; and that there is no extra danger to life and limb in the proximity of a gasholder or two. In considering its scope, it must not, however, be forgotten that the Act is experimental, and at present embraces only half the labouring population of the kingdom.

Probably there are few gas undertakings in the country which are not now beginning to feel the effects of the large increase in the cost of coal. For a long time prices have ruled so low that we have been in danger of thinking they would never get up again. Fortunately our bye-products, with the exception of tar, are commanding very fair prices. Sulphate of ammonia is now higher than it has been for a number of years; and it is sincerely to be hoped that the market will continue to improve. The Sulphate of Ammonia Makers' Committee, formed about a year ago, has been busily at work, and may possibly have had a share in bringing about this result. Its object is to encourage the use and application of sulphate. It has offered prizes for the best grown crops of various sorts raised with the aid of sulphate; has disseminated literature on its fertilizing properties; and is about to offer a prize of £500 for the best essay on the utility of sulphate as a fertilizer. Such a society should be patronized by all gas concerns; and though the report of the first year's working is not very encouraging, the continual bringing of such information before the farming and agricultural classes must make itself felt in time. Whether or not the address of Sir William Crookes to the British Association just lately on the importance of nitrogenous manure for wheat-growing will increase the demand for sulphate, it is difficult to say; but it very possibly may result in diverting for the use of this country many of the thousands of tons of this article which are annually exported to the Continent.

In connection with the manufacture of sulphate, makers who have hitherto simply burnt the waste gases and passed the products up a chimney are being impressed by the inspectors under the Alkali Acts with the fact that the law enjoins that they must employ the "best practicable means" to render the sulphuretted hydrogen evolved from the still innocuous. I believe I am correct in stating that the inspectors acknowledge three "best practicable means," which are as follows:—

1.—Conversion first into sulphurous acid, and finally into sulphuric acid in vitriol manufacture.
2.—Conversion into sulphur by means of the Claus kiln.
3.—Absorption in oxide of iron.

Of these three processes, the first is decidedly the best, and, in the long run, the most economical. But it entails a large amount of supervision, and even a skilled staff of its own; and the plant is costly and occupies considerable space. The Claus process is much less intricate, and is said to require very little attention; but the product, which should realize a sufficient sum, if pure, to at least pay the interest on the cost of the plant, is, in the case of sulphur produced from gas liquor, of such a bad quality that, unfortunately, it is almost unsaleable. One of the inspectors, when reporting on the manufacture of sulphate in his district, stated that he knew of no case in which the Claus process showed any profit. Both these processes are suitable for large gas-works; but when we come to small ones, there is no doubt that the oxide purifier, with revivification *in situ*, is the simplest and the best. It is stated that this method deals very satisfactorily with sulphuretted hydrogen from sulphate plants turning out not more than 300 tons of sulphate a year; but when this amount is exceeded revivification becomes very patchy and irregular, the oxide often fires, and the purifier becomes unmanageable. If, on the other hand, the purifier is emptied every time it is fouled, and the oxide laid out to revivify, the cost of labour is very serious.

Another method which has the approval of the inspectors is now coming into use, and is finding favour in gas-works which are too large for the absorption by the oxide method, and where the other means are considered undesirable. I mean what is known as the "limestone tower" process—an installation of which has just been erected at the Sunderland Gas Company's Hendon works. In it the sulphuretted hydrogen is first converted into sulphur dioxide by complete combustion in a furnace specially designed to retain its heat. The gases are then cooled and led into the bottom of a tower filled with tiers of limestone, through which the gases pass. The sulphur dioxide combines with the limestone, forming bisulphite of calcium, which, being soluble, is washed out by a shower of water from the top, as in an ordinary scrubber; and as the limestone wastes away fresh is supplied through suitable openings in the tower. In this process, there is no bye-product or residual, and there is a charge upon the manufacture of sulphate for limestone and labour; but the simplicity of the apparatus and the comparatively small first cost quite counterbalance these disadvantages.

As to tar, the outlook seems hopeless indeed, and prices have, I believe, never been lower than those quoted lately. We must not, I fear, expect very much, if any, benefit from Dr. Lilienfeld's discovery of the means of artificially producing albumen from tar products; for, as was stated in an article in the *Journal of Gas Lighting* a few weeks ago,* with the discovery of more and more useful products obtained from it, the value of tar gets less and less. If, then, there is anything in the Vienna Professor's discovery, tar distillers may well cry out to be saved from their friends.

I mentioned a few moments ago the existence of a Sulphate Makers' Committee; and this reminds me that another society has been very recently formed, or rather re-formed, which should prove of great assistance to the gas-making fraternity. It is the Gas Companies' Protection Association; the aims of which are to protect the property, revenues, rights, and privileges of gas companies, to secure united action, and generally to keep members informed of all parliamentary and other proceedings affecting their interests. Such an Association is surely worthy of support.

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* Vol. LXXII., pp. 299, 480.

A feature in the present-day methods of gas manufacture is the variety of means to our hands of enrichment. Only a few years ago cannel coal was the almost universal agent for this purpose; but this commodity becoming scarce, and consequently expensive, necessity became the mother of invention, and we now have at least half a dozen processes as substitutes—such as the Peebles oil and the oxy-oil processes, enrichment by benzol and petroleum vapours, and by admixture with carburetted water gas of high candle power, &c. Acetylene, that most brilliant of gases, may some day perhaps be used for enriching; but carbide of calcium will have to become very much cheaper than it is at present before this gas can be so employed. I understand that the cost of enrichment by means of acetylene is about 6d. per candle per 1000 cubic feet; and, in addition to this, it is very difficult to mix the two gases, owing to their different densities.

The use of carburetted water gas as an auxiliary in the manufacture of coal gas is coming more and more into favour; and quite a large proportion of the gas undertakings in the kingdom are now supplying 25 to 30 per cent. of it. The advantages of having a plant for the production of such a gas are so well known to the members of this Association that I will not venture to recapitulate them. The outcry against the increased percentage of carbonic oxide in the mixed gas supply is largely a matter of sentiment, and has been shown to be without any serious or substantial foundation; but since a Home Office Committee has been appointed to look into this matter, I fear that another instance of grandmotherly legislation may result. Should the proposal of the Committee as to the restriction of the amount of carbonic oxide during the hours of night ever assume legal force, the lot of the gas manager, who has to guarantee not more than a certain percentage of this gas in the outskirts of his district at stated times of the day, will not be a happy one.

Before bringing my remarks to a close, I should like to make a short statement on the consumption of gas in this town. Sunderland was first lighted with gas on March 9, 1824; and after some years of competitive supply in the shape of two rival Companies, the undertakings were amalgamated and formed into the Company at present existing. The Sunderland Gas Company has for the past ten years enjoyed the distinction of supplying gas at a price lower than almost any other in the kingdom. The charge ranges from 1s. 11d. to 1s. 6d. per 1000 cubic feet, according to the individual consumption; and the average price works out at 1s. 8d. The cheapness of the gas has naturally encouraged manufacturers in the district to use it very largely as a source of motive power; and at the present time there are over 300 gas-engines in use in the town of all sizes ranging from ⅛ to 50 horse power nominal. The engines of very small size are used principally for driving sausage machines, coffee grinders, lathes, printing and mineral water machinery, hoists, &c.; while the largest are found chiefly in ship-yards and engine shops, in many of which no other motive power is used. One or two firms on the Wear have each as many as ten gas-engines, with an aggregate of fully 450 indicated horse power; and in a great many works steam is being rapidly replaced by gas.

Mr. H. H. Wake, M.Inst.C.E., the Chief Engineer to the River Wear Commission, a few years ago introduced gas-engines for driving the pumps in connection with two large graving docks under his charge; and the installation has been an unqualified success. Five 40 nominal horse power engines—two for No. 1 dock and three for No. 2 dock—are employed for this purpose; each connected direct to a 22-inch centrifugal pump, with 66-inch disc, and capable of discharging upwards of 2600 tons of water per hour. The pump and engine are both contained on one base-plate. In order to show the efficiency of the installation, I may say that at the trial of one set of these pumps, 10,238 tons of water were pumped out in 1 hr. 58 min.; the pump starting against a head of 1 ft. 11 in., and finishing against a head of 20 ft. 3 in., with a consumption of 6695 cubic feet of gas, and a cost of 10s. Mr. Wake was the first to introduce direct gas-engine driving with centrifugal pumps; and the result has been so satisfactory that the method has since been adopted in several other parts of the country. Besides all this, gas-engines are used at the docks for revolving a swing railway bridge and for opening and shutting a pair of dock gates; also for working a 20-ton travelling crane, the gas supply being conveyed to it by means of a 3-inch flexible hose-pipe.

Taking into consideration the amount of gas used by all the engines in the town, and also that consumed for cooking and heating, it will cause no surprise when I tell you that the day consumption of gas in Sunderland is not inconsiderable. During the week ending July 9, 1898—which is taken as being a typical summer week—the quantity of gas delivered between the hours of 6 a.m. and 6 p.m. amounted to 43 per cent. of the total consumption. This, I venture to think, will be considered a very satisfactory state of affairs; and I may say that this percentage would have appeared even higher had it not been that in many works at that time night shifts were being worked owing to the briskness of trade.

And now, in conclusion, I must apologize for the absence of anything original or striking in my remarks. Presidential addresses become every year more and more difficult to prepare, and one finds oneself forestalled in every direction. I trust, however, I have not wearied you; and should anything I have said prove helpful to any of the members of the Association, I shall feel that my efforts have not been in vain.

THE POLICY OF DISCOUNTS.

A paper to be read by Mr. J. Holliday, of Scarborough, on "The Policy of Discounts," was on the *agenda*. The President explained that Mr. Holliday was unable to be present, but that Mr. Williams, of Scarborough, was with them, and he had kindly consented to read Mr. Holliday's paper. The paper was accordingly read by Mr. Alfred C. Williams, the Accountant of the Scarborough Gas Company, as follows:—

When our esteemed Honorary Secretary wrote me to the effect that all his applications or invitations for papers for this meeting had unfortunately proved abortive, it occurred to me that, although the question of the policy of a gas company allowing a discount on the gross price charged to private consumers of gas for prompt payment, is not by any means new, yet a few general remarks, together with some notes giving details of the working of, and general results obtained from, two systems of discounts from actual experience, might be of interest. Moreover it is a subject discussable from many points by all sections of the Association.

It may be as well to state here that the paper relates only to discounts for prompt payment, and does not touch on the question of differential rates or discounts for quantities consumed.

I must admit I was rather surprised, on taking out from the latest issue of the Board of Trade Returns for Authorized Gas Undertakings (other than those of Local Authorities), to find that, out of a total of 60 towns in the United Kingdom where 20,000 tons of coal per annum and upwards were carbonized, in only 11 cases had the principle of discounts for prompt payment been adopted.

The system of cash payments in businesses outside gas supply is becoming more general throughout the country, especially in the larger business towns, and has much to recommend it both from the side of the seller and of the purchaser. It is evident the producer, or seller, under competition, is in a position to afford to give a much better article, under ordinary conditions, for 20s. if he receives cash down than he would be if his customer required a six months' or longer credit. Or that, if he does give equal value knowing that credit will be required, he must charge a somewhat higher price for the article in order to cover the necessary clerical costs incurred, loss of interest, risk of bad debts, &c.; and I think logically the same argument may well be applied to the sale of gas. To supply the best article we can produce at the lowest price is undoubtedly the idea to be followed; and every point in the administration of a concern, on working, distributing, clerical, and subsidiary charges must be watched and taken full advantage of, so as to reduce the total cost to the lowest possible minimum, compatible, of course, with efficient work.

With this idea, my Directors some years ago decided upon the introduction of a system of discounts for prompt payment; and recently, after having had a most successful experience with their initial system, they decided to amend it somewhat for the mutual benefit of the consumers and the undertaking itself.

It is my intention, in the first instance, to describe briefly the main principles of these two systems, and afterwards give a few figures showing the results obtained from them respectively.

The first system adopted was to allow a discount of 3d. per *complete* 1000 cubic feet of gas consumed, if the amount was paid within six weeks of the end of the quarter. The following is a specimen of the notice inserted on the demand-notes:—

> DISCOUNT FOR PROMPT PAYMENT.—Discount at the rate of 3d. per complete 1000 cubic feet of gas consumed will be allowed if this account be paid not later than Tuesday, the 11th of August next, after which date the discount cannot be allowed.

The system answered very well, on the whole, with the following exceptions:—

(*a*) Some consumers had the benefit of a notice extending practically the *full* discount period—viz., six weeks—which was an undoubted advantage to certain classes (particularly small consumers), while other consumers had only a few days' notice in which to provide between the date of the delivery of the account and the termination of the discount period.

(*b*) Considerable dissatisfaction, and even friction, caused through no allowance being granted on the odd hundreds; that is, a consumer naturally felt somewhat "hit" when he examined his account and found he had consumed (say) 10,900 cubic feet of gas in the quarter, and was only going to be allowed discount on 10,000 cubic feet.

(*c*) On the last two days for discount each quarter, the strain on the clerical staff at our town offices, as I will show later, was considerable, and had a tendency to lead to errors in entry, mistakes in change, &c.

(*d*) A further objection bearing upon this point was the fact that, owing to the large number of accounts received during the last few days for discount, the greater part of a week was occupied in entering, posting, and totalling the items, which made it impossible to check each day the payment into the bank with the daily total of cash received.

(*e*) It was noticed that, among the accounts outstanding after the termination of the discount period, those consumers who had had the shortest period between the delivery of the account and the last day for discount preponderated to a considerable extent.

(*f*) We experienced considerable difficulty, and I may add unpleasantness at times, especially in the June and September quarters, with consumers who, through having probably let their houses for the holiday season, and leaving no address with the Company, did not receive their accounts in time to enable them to participate in the benefit of the discount.

It may be as well to state that the Directors laid down a firm rule to the effect that under no circumstances whatever could an exception be made to anyone missing the final discount day; and this rule was most strictly adhered to, with advantageous results.

The foregoing system was in operation for some thirteen years; but a short time ago, upon a reduction in the price of gas taking effect, it was decided, in order to obviate, as far as possible, the difficulties I have set forth, to amend it as follows: Discount to be allowed at the rate of 7½ per cent. (1s. 6d. in the pound) on the money value of the gas consumed, if the account is paid within *one* calendar month *from the date of its being rendered.* The notice on the demand-notes now appears as follows:—

> DISCOUNT ON GAS ONLY.—The above charge for gas is subject to 7½ per cent. discount (1s. 6d. in the pound), on condition that this account be paid within ONE CALENDAR MONTH from the date of its being rendered.

The benefits derived from the introduction of this alteration of systems are as follows:—

(*a*) The better distribution of the work in the office.

(*b*) Consequent on this, much less danger of clerical or cash errors arising.

(*c*) Allows cash-book to be posted *daily* throughout the year. (This has now become one of the fixed rules of the office.)

(*d*) Each consumer now has a precisely equal period between the date his account is rendered and the expiration of the time allowed for discount.

(*e*) The discount allowed being at the rate of 7½ per cent. prevents the frictions that arose over the odd hundreds under the initial system.

(*f*) Previously the collectors could not commence their "second" round, to call in outstanding accounts until at least a week after the expiration of the all-round *fixed* discount period. This meant that they had to face the whole of the accounts which had missed discount at one time. Under the amended system, the outstanding accounts fall in in sections; and this we find permits of their receiving better individual attention.

I now have pleasure in submitting a statement which I think speaks for itself as to the better distribution of the work. [See next page.]

You will observe that the largest number of accounts dealt with in one day was only 134, against 607 on the last day for discount under the old system. This, as you will all appreciate, was a very great point in our favour. It will also be noticed that the number of accounts received up to the end of July under the new system was greater by nearly 60 per cent. than that received under the old one. This improved state of things is partly due to the fact that very many of those consumers who had made a

STATEMENT *showing the Number of Accounts Received each Day from July 1 till the Last Day for Discount under the New and Old Systems respectively.*

NEW SYSTEM (4859 Consumers).

[7½ per cent. discount if account be paid within one calendar month from the date of delivery.]

1898.	Number of Accounts Received.
July 1	63
2 (Sat.)	35
4	59
5	52
6	49
7	78
8	41
9 (Sat.)	47
11	114
12	91
13	113
14	97
15	117
16 (Sat.)	55
18	114
19	80
20	70
21	82
22	79
23 (Sat.)	69
25	134
26	118
27	132
28	115
29	116
30 (Sat.)	84
	..

Total at end of July, 2204

Aug. 1	Bank Holiday
2	104
3	83
4	45
5	67
6 (Sat.)	54
8	130
9	73
10	75
11	106
12	99
13 (Sat.)	74
15	94
16	55
17	37
18	50
19	23*
Total	3373

OLD SYSTEM (4703 Consumers).

[3d. per complete 1000 cubic feet allowed if account was paid within six weeks from July 1.]

1896.	Number of Accounts Received.
July 1	39
2	33
3	22
4 (Sat.)	4
6	15
7	14
8	42
9	27
10	43
11 (Sat.)	14
13	43
14	33
15	39
16	69
17	76
18 (Sat.)	13
20	67
21	80
22	80
23	69
24	68
25 (Sat.)	31
27	93
28	130
29	106
30	71
31	67

Total at end of July, 1388

Aug. 1 (Sat.)	47
3	Bank Holiday
4	115
5	104
6	113
7	124
8 (Sat.)	82
10	480
11	607
Total	3060

[* Last day for discount.]

Greatest Number of Accounts Received in One Day.

New system	134	Old system	607

practice of paying their accounts on the last days for discount now "take time by the forelock," and pay soon after the delivery of the demand-notes, lest procrastination shall result in the "calendar month" slipping by, and their then losing the much-desired discount.

Five years prior to the introduction of a discount system, the amount of bad debts per 1000 cubic feet of gas sold (excluding public lighting) averaged 0·34d. During the succeeding five years, the average decreased to 0·24d.; and the average of the past five years was 0·13d., while for the twelve months ending June 30, 1898, it had fallen to 0 10d. per 1000 cubic feet sold.

At the close of the discount period on the past quarter's accounts—Aug. 19 (the delivery of the accounts having been completed by the 19th of July)—the amount outstanding was £559, or 8·7 per cent. of the total amount due on the 1st of July. Two years ago the discount period expired on the 11th of August, when £760, or 13 per cent., was outstanding. Giving the old system the benefit of the receipts from Aug. 12 to 19, the amount outstanding was £672, or 11½ per cent., against the figure of 8 7 per cent. quoted above.

Taking the question on the whole, I have no hesitation in supporting the statement of Mr. Newbigging, who in the last edition of his "Handbook" (p. 460) says, on the question of "Discount for Early Payment of Gas Bills," "The practice, wherever adopted, has been found highly beneficial, saving labour in collecting, and reducing the percentage of bad debts."

Discussion.

The PRESIDENT hoped the paper would lead to an animated discussion. There were differences of opinion upon the subject; and they ought to have samples of each.

Mr. HENRY TOBEY (Malton) said it appeared to him that the principle of the discount system was this, that they allowed something off accounts for present payment, instead of letting payment be deferred to a future period. When they looked at the discounts given by gas companies—from 5 up to, in some cases, 25 per cent.—and considered the apparently light risk, it was quite evident that no business man would give them. A discount of 25, or even of 10 per cent., was vastly in excess of the advantage to be gained by taking present instead of future payment. Most gas companies issued their accounts quarterly; and the consumer was probably called upon by the collector, in the ordinary way. If he did not then pay, he was allowed to run to the end of the three months—that was all.

He (Mr. Tobey) thought it was a general rule that a gas bill was to be paid before the next quarter became due. If a consumer were granted discount for payment within four weeks, he thought it was evident that the gas company were giving more than the equivalent. Suppose the account were £100, and the consumer got £5 of discount for payment within four weeks, it was a very considerable sum to allow for receiving cash two months earlier than it would otherwise have been got in. The gas company might have gone into the market and borrowed the money, or they could have raised it as capital to much better advantage. He supposed that a company, in giving discount, wanted to have cash in hand, so that they might work with less floating capital than they could if they allowed longer credit. But a company who allowed 5 per cent. discount was certainly making a great mistake, from his point of view. If they raised capital at 7 per cent., £100 for three months only amounted, in dividend, to something like 35s.; and thus an allowance of £5 appeared to him to be vastly in excess. It was beyond all the rates of commercial trading to give 5 per cent. discount for payment in one month, instead of in three months. Perhaps these heavy discounts were allowed more as a differential rate to large consumers. In this case it was really not a discount for cash paid promptly, but a differential rate with the condition attached that the parties who wished to take advantage of it should pay promptly. In regard to sliding-scale gas companies (he believed that the Scarborough Gas Company was a maximum-price Company) whose dividend was regulated in proportion to the price they charged, it appeared to him that discount was altogether a false method to go upon. Suppose they took 3d. per 1000 cubic feet off as discount, they would not be allowed to calculate their dividend upon the price after taking off the 3d.—they would be obliged to take their invoice price. They would not certainly be allowed to take advantage of a decrease in price by discount, because all the consumers would not be getting the benefit of it. It appeared to him there was very little advantage in a company which had a good working district, allowing a discount at all. He was rather inclined to think that they might collect their accounts—and many did so collect them—with very little trouble, in the ordinary way. The company were the only people supplying the article in the district; and if it were known among the consumers that they would not be allowed to go beyond a certain date without paying their accounts, they would pay them. There was no need for the inducement of a discount to urge people to pay their accounts, because, if they got a limited time, and knew that they would not be allowed to go beyond, they would pay up. There was another point in the paper which he noticed. It was one of the difficulties which Mr. Holliday said arose under the former system, and which he did not appear to have got rid of under the new system. That was with reference to people who let their houses. He thought they were not more likely to get payment from them under the new plan than under the old one.

Mr. E. H. MILLARD (Durham) said that, having been associated with a discount system in more places than one, he should like to bring a few points before the meeting. In the first case, the discounts allowed ranged up to 10d. per 1000 cubic feet, on a selling price of 2s. 10d. He was certainly disposed to agree with Mr. Tobey that this was out of all due proportion to the amount received. In another case, the discount was 9d. off a selling price of 4s. 6d. This was not such a high proportion; still the disadvantage was there. When he went to Durham, no discount system was in vogue; but now there was. Anybody taking up the discount system must make a point of keeping firmly to the day allowed, even if the consumer should be one of his own directors. He remembered a friend of his who had an account owing, and who had gone a day beyond the time allowed for discount. His friend asked for the discount; and he allowed it. Unfortunately, his friend did not keep the matter to himself; and the result was that others made similar applications. He had been exceedingly careful since then not to give discount, no matter to whom, if the time was exceeded by even a single day. The system followed at Durham was to stamp the account with the date of delivery, and also with the last date for discount to be allowed, so that no mistake could be made by the consumer. He found that many people came in and said that they had lost their account, but that they knew it was due on a certain day. They might be prepared for this by keeping a sort of diary of the dates; and they would thus probably find these lost accounts to be, not one day, but three or four days, behind the time. They had gone in largely for posting the invoices, in order to get rid of the difficulty of some people having longer time than others. It was also much cheaper to post them, under a halfpenny stamp, than to deliver them. Another point was that where a heavy discount was allowed, people were much inclined to think that the gas was dear. They would look at the 2s. 10d. per 1000 cubic feet, but not at the 10d. off. His experience of the discount system was that the very people who were behind with their payments in ordinary circumstances, were also the people who were behind when discount was allowed. They were practically the same people; and he certainly thought that, from the amount of trouble these people gave to the collector, they ought to be penalized in some form or other. He considered that a discount system was a very good one for that, provided they did not exceed a moderate amount. One of the reasons they had for adopting the discount system at Durham was the cost of collecting the money received through penny-in-the-slot meters; and he might say that they had been enabled to deal with something like 1000 slot meters, in addition to the other duties, without increasing the office staff, simply by introducing the system of posting the accounts and allowing discount to the people who brought their money into the office. By sending out a certain number of bills day by day, the office work was kept very regular.

Mr. W. J. Warner (South Shields) said it appeared to have been overlooked that the discount system was not entirely in the hands of the gas companies. In his own case, there were some large manufacturers who made their own gas; and on approaching them with a view to their becoming customers of the Company, these manufacturers said: "What price will you supply us at?" Then, of course, they had competition between these works and their own. In some cases they made arrangements which were satisfactory to both parties. Subsequently, when the Company went to Parliament, some of the manufacturers who had not joined them—people of considerable influence in the town—said: "We have not taken your terms nor accepted your conditions, because we have our own plant at work, and can therefore make gas at a cheaper rate than you can supply us at; but it may so happen that our plant may not be sufficient for our purposes, or it may require renewal, and then the question might be whether we should not come to you for our supply. The price should thus be somewhat approximated to the cost at which we have been making gas." Hence, a scale of discounts was forced upon them by the authorities—discounts of from 5 up to 30 per cent. Fortunately for them, they had to go to Parliament again; and they then got these rates to some extent limited. Still, their rates were too high—at least, so they thought. He gave these facts in reference to South Shields because it appeared to be overlooked that gas companies were not masters in the matter of discounts.

Mr. J. H. Cox (Sunderland) said that they had discounts in Sunderland—varied in order to get into their net those large consumers to whom Mr. Warner had alluded. They allowed from 1d. up to 6d. per 1000 cubic feet. A man who burned half a million cubic feet of gas per quarter got it for 1s. 6d. per 1000. By these means they were enabled to fight against electricity to a certain extent, and also against other modes of producing gas for the purpose of propelling dynamos. He was inclined to think it was not a question of payment at all, but of giving a bonus to the person who used a larger quantity of gas than did small consumers. With small consumers, they had a large amount of trouble. They had four accounts to make out for them every year; they had eight or twelve inspections of the meters every year; and they had a separate service pipe, and a separate meter, for each. They had other consumers, who used £2000 worth of gas a year; and in their case they had probably only about fifty calls a year to get in this sum; and they had a very small proportion of service-pipes and gas-meters. To get £2000 from small consumers they would require some 2000 meters, 2000 service-pipes, about 8000 calls of the inspector every year, and about the same number of calls of the collector. Mr. Holliday's method of giving a fresh date to every consumer appeared to him (Mr. Cox) not to be a simple arrangement. He knew that it acted very well; but, as Mr. Millard said, the very people who did not pay under one condition, would not pay under another. There were a lot of people who would not pay unless there was some threat hanging over them. He found no difficulty at all in getting money under his present system, at the proper time.

Mr. **Herbert Lees** (Hexham) said that he had had some little experience in the matter of allowing discounts for prompt payment. They should not lose sight of the fact that Mr. Holliday's paper dealt simply with this; it did not deal with the question of discounts for large consumers. He thought that Mr. Tobey, in his criticism, had overlooked the main point for which these discounts were allowed. Mr. Tobey spoke as if the discounts were given in order to get in cash promptly, which was not the only reason. They were allowed for the purpose, also, of inducing consumers to pay their accounts at the office, and thus save the cost of collection. He took it that no such discounts as 5 or 10 per cent. would be allowed for prompt payment only. There was no doubt that by the adoption of a discount system, a saving in the cost of collection was effected, and that the saving was a considerable one. He was free to admit that the system had its disadvantages; and one of these was pointed out by Mr. Millard—that the gross price of gas was always quoted as that at which they sold it, and the net price never was. It was very difficult to convince people if the gross price were 3s. 4d., that they were selling at 3s. per 1000 cubic feet. This might appear to be a sentimental rather than a practical difficulty; but, in his opinion, it was a difficulty which they had. It was, for each of them, a question of the advantages or disadvantages which they would have by the system, and they would have to consider it, each for himself. His Directors had not such a strict rule as had been mentioned, as to allowing discount after the time had expired; but he dealt with cases as well as he could, using his discretion, and he never made an enemy.

Mr. J. T. Jolliffe (Ipswich), on being invited to address the meeting, said there was one point which struck him in regard to the matter of discounts, and that was that they could not lay down any hard-and-fast rule upon it. Personally, he was opposed to discounts. He never could see the reason for giving any discounts—beyond 5 per cent. certainly. He took it that in all their undertakings the cost of collection did not exceed 0·30d. per 1000 cubic feet; and he took it also that in most undertakings it did not exceed 0·25d. So that it appeared to him that if they gave a discount of 5 per cent., or, as Mr. Holliday did, of 7½ per cent., upon the gross price of the gas, they were giving considerably more than any saving in the cost of collection they could make by giving discount. Of course, there might be some particular case in which it would be desirable to make these large concessions; but it appeared to him that it was manifestly unfair to the bulk of their consumers, who used gas simply for lighting purposes, if they gave such an enormous allowance as 5 or 10 per cent. to those who were users of gas for power only. He knew that he might be speaking upon points on which the meeting would disagree with him, because his views might seem to discourage the day consumption which they had all been trying to obtain. But it seemed to him to be forgotten that where gas was used for power or heating purposes (especially in the depth of winter), there was a considerable amount of overlapping of the heating with the lighting consumption; and they would have to make provision for this extraordinary demand upon them in the depth of winter. Therefore, their apparent gain was, as it were, swallowed up.

The Hon. Secretary remarked that, although discounts were forced upon them at South Shields, they worked very satisfactorily. He rather admired the system; and he thought they got very good, practical benefit from it. He had looked at their accounts a day or two before, and he found that their collectors, up to the last day of the discount, got in about 40 per cent. of the rental; that on the last day of the discount they got about 55 per cent. of it, leaving a residuum of about 5 per cent. He thought it was a great saving in collection. They got a good balance at the bank four times in the year, which was very useful. Of course, there were difficulties on the last day for the discount, if 55 per cent. of their consumers called upon them on that day. But then they could provide for this—they could put the whole of the staff on to the work. There were people—it was very tantalizing, of course—who came without their accounts, and someone had to make them out afresh. Then, perhaps, the worst difficulty was with the people who came after the last day with all possible excuses. They generally tried to clinch their argument with the remark: "Your neighbours are not so strait-laced as you are, by three or four days." But they had a last day; and they stuck to it. He was sorry to say that a great many of their consumers thought that the last day was *the* day. They gave six weeks to pay; and they never allowed discount after that period, because it would not be fair to those who had paid before.

Mr. JOLLIFFE asked if Mr. Penney would tell them what was the cost of collection per 1000 cubic feet.

Mr. PENNEY said he did not know that he could do so, but it was very small.

Mr. W. FORD (Stockton) said in Stockton they had always had a uniform discount of 20 per cent. to all consumers—the largest and the smallest; and they had found the system worked very well. In a considerable number of cases the discount was lost; but it was very gratifying to know that in no case during the last 30 years had the rule as to the last day been broken through. With a gas revenue of something like £40,000, they had only one collector. About 60 per cent. of the total amount due was carried to the office long before the last day for payment. The balance, he should say, was not more than 5 per cent. on the last day of the accounts being due. Consequently, they had, he was sorry to say, not a large balance at their bankers, but they had the satisfaction of knowing that they had the use of the money four times in the year, when they received it. Otherwise they might have to pay 6 or 7 per cent. if they overdrew their account at the bank. His opinion was quite in favour of discounts—not, perhaps, so large as they had been giving; but 10 per cent. would be found to be most serviceable to any corporation or gas company who might try it.

The President thought the policy of discounts must very largely depend on the character of the consumption. What was found to be suitable in the one case, would not necessarily be suitable in another. Where the uses of gas were of a very diversified character, a large discount was probably advisable; but, on the other hand, where they were more general and uniform, smaller discounts ought to serve.

Mr. Williams, in replying to the discussion, said that the remarks which had been made had not been so much in the nature of direct questions as criticism of the general question. Therefore he had no questions to answer; but he thought that he might be able to clear up one or two points which did not appear to be clear. If the actual amount of discount allowed were a charge on the undertaking, and appeared on the debtor side of the accounts, as carbonizing wages or the like did, it would be a serious matter. But this was not a charge on the undertaking, in the sense that the quantity of gas used was increased by the discount. If there were no discount claimed in Scarborough, they would probably be able to sell their gas at 2s. 7½d. or 2s. 8d. per 1000 cubic feet at the outside, and still make exactly the same profits as at present. The main benefit of discounts, in his opinion, was that it brought in the money promptly; and—perhaps chief of all—they had much more pleasant relationships with their consumers. There was, in human nature, a liking to have something back, and when the consumers came and paid their money, they smiled, and left the office in good temper, on finding that there was something to get back. He had had experience of both plans; and he could speak in the highest terms in support of the discount system. As to the details of the system, they might have a fixed date by which all accounts should be in, or they might give each consumer the same length of time, which was, of course, by far the fairer method. But the principle was the same; and it would be found, he ventured to think, to work extremely well. At Scarborough, they had not very much in the way of local manufactories. Their consumers were comparatively small ones; and they had not such difficulties to deal with as Mr. Warner and Mr. Cox had referred to. They had no differential rate, because their consumers were much of the same size. In regard to the sliding-scale which Mr. Tobey referred to, he was not able to give them an opinion upon it; but he should certainly think a fair method would be to take the price at the net rate, because, in the case of Scarborough, 92 per cent. always availed themselves of the discount. But no doubt a clause in an Act of Parliament would put this right. As to the letting of houses, they found that the new system did improve matters to this extent—that in the case of those who let their houses, the accounts might be delivered, and while under the old system they might only have a fortnight from the date of delivery to pay, under the new method the account might be delivered about the beginning of the month, and they might have returned to Scarborough before the month had expired. It was their experience that they required to be firm as to the final date. They had a printed form which they sent out to all, treating everyone alike, on which was the date of delivery and the calendar month; and in this way there could be no mistake as to the terminal date. As to posting the invoices, they had had the subject before them several times, but had not yet introduced the system. Mr. Cox spoke of the arrangement as to the expiration of the discount period not being a suitable one; but in his opinion it was very convenient. A note was made in the gas ledger of the dates when the accounts were delivered; and when anyone came to pay, they could easily refer to the ledger. But they found that probably not one in a hundred came without his bill; because they had on the top of the bill a printed notice that it must be produced at payment. The expense of collection was certainly reduced by the discount system; but a great deal depended upon what they took as the cost. Of course, the clerks at the counter who received the money were virtually collectors; and a portion of their time was a charge upon the collection. He thought there was no great trouble in getting to know the net price of the gas, and that it was the actual money paid, and not the amount stated in the invoice, which should be the comparative figure. Mr. Penney had spoken of the last day of discount being rather a difficulty. Well, they had this system of fixed dates; and, as they would see, they received payment of not less than 1000 accounts in two days, out of a total of 3000. After introducing the system of allowing a calendar month, the accounts fell due at various times during the month. The average number received was about 80 per day; the highest being 134, as against 607 on the last day under the old system. This, also, enabled the cash-book to be posted up daily, and the payment to the bank checked before it was made. He highly supported the discount system; and he thought that those who had once adopted it, would not go back to the system of no discounts. In conclusion, he thanked the members for the way they had received the paper.

VOTES OF THANKS.

Mr. H. LEES said it afforded him great pleasure to propose a vote of thanks to Mr. Holliday for having written his paper, and to Mr. Williams for having come there to read it. They were all very sorry at Mr. Holliday's absence; but they welcomed Mr. Williams as his substitute. The way he had replied to the discussion had been most gratifying to everyone.

Mr. MILLARD seconded the proposition, and it was carried.

Mr. WILLIAMS returned thanks on behalf of Mr. Holliday.

Mr. WARNER said he was going to step a little bit out of the ordinary current of their business, in proposing a vote of thanks to the President. The President had told them of the large number of gas-engines in use within the district of Sunderland. Some of the older members of the Association would at once go back with him, mentally, to the year of the gas exhibition in South Shields. On that occasion, they had two comparative toys of gas-engines exhibited. One they had some little trouble to get started, and to do its work, which was sawing a deal. The other they were not quite so successful in starting; and, in fact, he did not think it started at all. They put, or attempted to put, different kinds of work upon it, from a little water-pump to the operation which the other engine was performing. This was the introduction of the gas-engine to gas manufacturers. It was the year when their Association had its birth. The exhibition was a very successful one; and it was exactly the power which gave gas cooking and heating the push which it just at that time required. It was so successful that it was followed in other towns. Why he referred to this was that in one part of the address of the President he seemed to look back, to a certain extent, and to be of opinion that they had not made any great amount of progress within the 21 years of their existence. But, if they looked a little deeper, it was not so. They would see that many momentous questions had been raised since then. They were met on an auspicious occasion. He, as their first President, wished their present President God-speed in his year of office. The manner in which he had conducted their business that day was a proof that the gathering would be looked back upon as a very successful one. He had great pleasure in asking them to recognize the services of the President by a very cordial vote of thanks.

Mr. J. HEPWORTH (Edinburgh) said that he was permitted—as being, he believed, the second President of the Association—to second, as he did most cordially, the vote of thanks. Unfortunately for him, the President's address was always, by some unwritten law, supposed to be a matter not for discussion; but he could assure the President—having once been in the chair himself—that however true this might be while in the meeting, the moment they got outside they should begin discussing it in all ways. He ventured to say, in regard to the address at all events, that there would only be one conclusion at the end of their discussion, which would be that it had been one of the ablest addresses they had ever had from the chair.

The President thanked the members very much indeed for the extremely kind acceptance of the motion, as well as for the way in which it had been proposed. It was most gratifying to find that his efforts had been so successful. He could only feel that he did not deserve half the flattering remarks which had been made about him.

This terminated the meeting.

The members and their friends were afterwards entertained to dinner by the Sunderland Gas Company at the Palatine Hotel, in the Borough Road; Mr. Stokoe, the Chairman of the Company, presiding.

MIDLAND ASSOCIATION.

AUTUMN MEETING, OCT. 27.

This Meeting was held at the Grand Hotel, Birmingham, under the presidency of Mr. J. T. LEWIS, of Wellingborough. There was an unusually large number of members present; and they observed with gratification that the President looked none the worse for the accident which befel him during the visit of the Association to Wellingborough in May.

CONFIRMATION OF MINUTES.

The HON. SECRETARY (Mr. Charles Meiklejohn, of Rugby) read the minutes of the previous meeting; and they were confirmed.

ELECTION OF OFFICE-BEARERS.

The PRESIDENT said it gave him great pleasure to propose, as President for next year, their esteemed friend, Mr. J. S. Reeves, of Bilston. He was one of the members who had done a great deal for the furtherance of the interests of the Association—as a member of the Committee, as an Auditor, and for some period as Honorary Secretary; and he (the President) was sure the nomination of Mr. Reeves for the highest office would meet with hearty approval, seeing that in him they had a man who was qualified in every way to preserve the best traditions of the Association.

Mr. B. W. SMITH (Smethwick) expressed his pleasure in seconding the motion, and in endorsing the remarks of the President.

The motion having been unanimously adopted,

Mr. REEVES thanked the members for the honour they had done him.

On the motion of Mr. P. SIMPSON (Rugby), seconded by Mr. J. F. BELL (Stafford), Mr. T. Berridge, of Leamington, was unanimously elected Vice-President.

Mr. BELL having returned thanks,

Mr. W. BELTON (Shrewsbury) proposed the re-election of the

Treasurer, Mr. Peter Simpson; saying he believed he was one among the first few who founded the parent Association.

Mr. C. TAYLOR (Derby) seconded the motion, and it was agreed to.

Mr. SIMPSON thanked the members; remarking that there was nothing that gave him greater pleasure than to be able to do something for the Association and profession. He was one of the first who arranged meetings of gas managers; feeling the need of them then very much. He considered at that time, as he did now, that one of the best things for the profession was for friends to meet together to discuss matters that would be beneficial to them; and it gave him much pleasure to see the progress that had been made.

Mr. T. GLOVER (West Bromwich) proposed that Mr. Meiklejohn be asked to continue in the office of Honorary Secretary.

Mr. W. R. COOPER (Banbury) seconded the motion, which was heartily adopted.

Mr. MEIKLEJOHN briefly thanked the members for the confidence they showed in him by his re-election. Proceeding, he proposed that Mr. W. Winstanley (Newcastle-under-Lyme) and Mr. H. P. Maybury (Great Malvern) be appointed members of the Committee in the place of Messrs. Parlby and Meunier, who retired by rotation.

Mr. REEVES seconded the motion, which was passed.

The election of Mr. Maybury to the Committee rendered vacant his position as one of the Auditors; and Mr. Berridge was appointed to succeed him, to act in conjunction with Mr. Percy Winstanley, of Nuneaton.

The next item on the *agenda* was a paper by Mr. W. S. M'GREGOR (Longton) on

THE RECONSTRUCTION OF THE LONGTON GAS-WORKS.

The HON. SECRETARY stated that the previous morning he received a letter from Mr. M'Gregor, suggesting that his paper should be taken as read, on account of the fact that it had been already to some extent, or largely, anticipated in the publication of an account of the opening of the new works at Longton. He (Mr. Meiklejohn) did not know what the feeling of the meeting might be on the matter; but he simply wished to say that this was the first intimation he had had that any of the information regarding the extensions that Mr. M'Gregor promised him some time ago for a paper would be published before being brought before the Association. It had placed him and the Committee in rather an awkward position.

The PRESIDENT said the Committee were much surprised to find that Mr. M'Gregor's paper* was published in the *Journal of Gas Lighting* on the previous Tuesday—only two days before the meeting. It seemed strange that this publication should have taken place, because the paper was promised a considerable time since for the meeting. Consequently, the Committee felt that, because the paper was practically the same as the "paper" in the *Journal*, they could not accept it for publication in the transactions of the Association. The Committee regretted this; but it must be so. They felt most strongly that, if a paper was promised by a member, that promise should be held sacred. So far as the purport of the paper was concerned, nothing whatever should be published until the paper was read at a meeting of the Association. It was open to the members to say if they were satisfied with the Committee's action. He should be glad to hear any explanation Mr. M'Gregor had to offer.

Mr. J. F. BELL (Stafford) suggested that Mr. M'Gregor should offer an explanation before any discussion took place.

Mr. M'GREGOR said he was sorry this had occurred. The opening day for the works was not fixed by himself. It was originally intended that it should have been that day [the 27th]; but it so happened that the date was inconvenient. It did not occur to him that the *Journal* would be able to get their article in type and published before the meeting. He was very sorry that this had offended the Committee. There had not been the slightest idea of anything of the kind on his part. He had no doubt the Committee were quite within their rights in the course they had taken; but he need not say more as that was pretty well the whole explanation.

Mr. BELL: Cannot Mr. M'Gregor give us some details that are not published in the *Journal*?

The PRESIDENT: The brakes to convey the members to the Saltley Gas-Works have been ordered here earlier on account of the decision of the Committee.

The HON. SECRETARY said that, anticipating the paper would be taken as read, he had arranged for the conveyances to be at the hotel at 2.30. If they had not left until three o'clock it would have given them only a short time at the works before darkness set in.

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* In an editorial note to the *Journal* report of the proceedings at the meeting, it was pointed out that the President was utterly mistaken in describing the article as a "paper," inasmuch as at least two-thirds of it consisted of altogether different matter from anything appearing in Mr. M'Gregor's communication. The article in question, accompanied by a ground plan of the Longton Gas-Works and a section of the retort-house and railway sidings, will be found in the *Journal* for Oct. 25, 1898.

THE SALTLEY GAS-WORKS EXTENSIONS.

Mounting the conveyances, the members at once proceeded to the Saltley Gas-Works to view the operations in progress in connection with the large extension scheme. They were received with the greatest cordiality by the Engineer (Mr. Henry Hack, M.Inst.C.E.), who, having conducted them into a temporary structure at the entrance to the new works, prefaced the inspection by explaining to them, in a general way, the character of the work in hand and that in prospect.* In the erection of a large 8¼ million cubic feet gasholder, Messrs. C. & W. Walker had adopted a method of construction which greatly facilitates the progress of the work. The sides of the lifts were being delivered in large segments already riveted; and these had to be simply lowered in position, and riveted together. Each piece was about 7 feet wide, and the full depth of the holder, with the vertical guides and the stays inside and out riveted on. Mr. Hack was aided in guiding the members round the works by Mr. Morrison and other assistants. Having completed their survey of the storage extensions, and of the preparations which were being made for the carrying out of further sections of the scheme, and having inspected the water-gas plant, the visitors were kindly invited by Mr. Hack to take tea in the temporary building in which they had previously been welcomed.

A RETRACTATION.

The members having finished tea,

The PRESIDENT said he desired to take this opportunity of making a few remarks with reference to the paper which Mr. M'Gregor had prepared for the meeting. Since the members left the Grand Hotel, he and several others had received an explanation which had put the matter in a different light. He was pleased to say this, because to him (the President) and to the Committee it was most distasteful to say or do anything that might seem to be in the slightest degree unjust to anybody. He found that the facts of the case were somewhat as follows: The representative of the *Journal* was present at the opening of the new works at Longton by invitation; and while there he used his opportunities as a journalist—and rightly so—to get all the information he could about the works and the alterations that had been made. In preparing his article, he doubtless did not know the purport of the paper that was to be prepared by Mr. M'Gregor and given to the Association at their meeting that day, nor that the article would practically cover the description which the paper would give of the reconstruction of the Longton Gas-Works. If they had had these facts before them in the afternoon, he thought that, at any rate, the members would have allowed the paper to be taken as read. He considered, in justice to Mr. M'Gregor and to the *Journal*, this explanation should be made; and, on behalf of the Committee, he begged to propose—"That the paper prepared by Mr. M'Gregor should become part of the transactions of the Association."

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* The extension scheme was described at some length in the *Journal of Gas Lighting* for Oct. 18, 1898.

Mr. J. S. REEVES (Bilston), in seconding the motion, said that, after the lucid remarks made by the President, he had little to add, excepting this: In deference to the wishes of his Committee Mr. M'Gregor prepared an illustrated statement setting forth the nature of the extensions for the use of his Committee and such persons as were interested in them at the opening of the new works, and this statement was to form the ground or basis of the paper he was to read. As Mr. M'Gregor explained at the meeting, he expected that the opening of the extensions would have taken place on that day [Oct. 27] or on a subsequent day; and then the Association would have had the description before them previous to any portion of it being published. But it was thought desirable to begin working the new plant earlier; and, of course, Mr. M'Gregor had to consider his Committee before the Association. He (Mr. Reeves) thought it would appear to the members, under these circumstances, that they would be doing right in reversing the decision arrived at at the meeting. They did not wish to do an injustice to anyone; and, after the explanation that had since been given, they would be doing Mr. M'Gregor an injustice, and giving him pain, by not rescinding the previous resolution.

Without further remark, the motion was unanimously carried.

THANKS TO MR. HACK—THE DEVELOPMENT OF THE SALTLEY WORKS.

The PRESIDENT said his next duty was to propose, on behalf of the members, a vote of thanks to Mr. Hack for his great kindness to them that day. It was not the first time by many that they had had the privilege of looking over the works controlled by Mr. Hack. Many were the times he (the President) remembered the members had been there, and had been shown whatever was to be seen in the way of extensions; and he need not point out how extremely valuable these opportunities were to them all. They had indeed seen some fine examples of engineering skill and construction.

Mr. HENRY WOODALL, in seconding, remarked that they had known Mr. Hack for a great many years; and he had always shown great kindness in assisting the Association. Whatever they wanted to see in the way of gas-works, they could see in its best form under Mr. Hack's engineership.

The motion was carried by acclamation.

Mr. HACK said he was much obliged to the members for the vote of thanks they had accorded him. It had been that day, as in the past, a great pleasure to do what he could to serve the interests of the Association. He was always glad to see his *confrères* in the profession at the Saltley works—whether he had anything in the way of extensive works in hand or at other times. He felt that he was only reciprocating the many kindnesses he had received when visiting other works. In looking over each other's works, they learnt some things at one place and some at another, and so often gained a useful wrinkle. What the members had seen that day must have impressed them that the Corporation Gas Committee and their Engineers—Mr. Hunt and himself—had no misgivings as to the future of gas lighting. Notwithstanding that the Corporation had recently taken over the electric lighting works, the great progress of the gas undertaking had forced upon them these extensions. Although they had acquired the electricity supply, they did not foresee anything that was going to deter the progress of gas; and they believed it would continue to move forward as in the past. In order to show the great advancement that had been made, he might just mention that the production of gas had increased by no less than 118 per cent. since the transfer of the works to the Corporation in 1875. The make of gas in that year was 2,327,596,000 cubic feet, while in the past financial year it was 5,074,865,000 feet; and this, notwithstanding that several of the out-districts—Oldbury, West Bromwich, Tipton, and Smethwick—had severed themselves from Birmingham. If they had not done so, the increase would have been a great deal more. Even since the electric light was started in the city in 1891-2, the increase in the make of gas had been to the tune of 25 per cent. In 1891-2, the make was 4,045,006,000 cubic feet; and in the past year, 5,074,865,000 cubic feet. In his opinion, both gas and electricity would run alongside for many years to come; and they need not fear that gas undertakings were in, or likely to fall into, a moribund condition. In connection with the present extensions of the gas-works, it might be interesting to the members to learn that, at the time of the transfer, the greatest daily make at Saltley was 4,817,000 cubic feet; while in the past financial year it was 11,906,000 cubic feet. The present daily capacity was: Coal gas, 10,250,000 cubic feet; and water gas (with plant in reserve), 3,250,000 cubic feet—making a total of 13,500,000 cubic feet. Adding to this the capacity of the extensions on hand—coal gas 5,000,000 cubic feet, and water gas 2,000,000 cubic feet—made 20,500,000 feet. Then when the scheme was completed, a further 5,000,000 feet of coal gas would have been added—giving Saltley a daily capacity of 25,500,000 cubic feet. There was no doubt the gas industry would go on prospering; and certainly in the lifetime of those present they would not be able to call it a decaying industry.

The PRESIDENT also proposed a vote of thanks to Mr. Hack's assistants for their attention during the tour of the works.

Mr. B. W. SMITH (Smethwick) seconded the proposition; and it was unanimously passed.

Mr. MORRISON having responded, the company returned by the brakes to the Grand Hotel, where they dispersed.

The following is the paper prepared by Mr. M'Gregor:—

RECONSTRUCTION OF THE LONGTON GAS-WORKS.

It may be stated at the outset that the design, manipulation, and control of all mechanical appliances introduced into gas-works has now become a subject of the very greatest economic importance; and the majority of gas engineers, in designing modern works, arrange for their introduction with a view to economy and less dependence upon skilled labour, besides the greater facilities obtained for handling material—objects to be all the more strongly borne in mind in view of the Workmen's Compensation Act, and its probable demands upon employers. Gas making has changed but little during the last fifty years—*i.e.*, the principle remains the same, although many improvements have been made for carrying on the process. Still, as it is the aim of every engineer to produce the greatest quantity of gas from a ton of coal at the smallest cost for wear and tear, fuel, and labour (due consideration, of course, being given to the quality of gas supplied), this principle has to a very great extent guided the writer in designing and carrying out labour-saving appliances during the reconstruction of the Longton Gas-Works.

The new retort-house is 90 ft. 6 in. long by 70 feet wide between walls, and 35 ft. 6 in. from ground-level to wall-plate.

It is a plain but substantial building of two floors—the basement and working floor—presenting a massive appearance, quite in keeping with the work for which it is designed. The basement or cellar floor is used for discharging and cooling the coke, and attending to the furnaces. From the basement floor, access is had to the underground engine-rooms, where a 10-horse power engine of the vertical type is used to drive the coal breaking, elevating, and conveying machinery. The walls are lined with white glazed bricks; and these, of course, give a cheerful and cleanly appearance to the engine-rooms.

The working floor is carried on heavy steel girders, supported on cast-iron columns and steel joists with brickwork arches. In fact, throughout the whole of the work steel has entered largely into the construction, owing to its superior qualities of lightness and strength. It is rather unusual to design a house of this size with two floors. The reason that this type of house was adopted was that a large drainage culvert passes directly across the site, about 4 feet below the yard-level; and as this precluded the building of a cellar for the regenerator retort-settings introduced, it was finally decided to build a stage-floor house, which, though somewhat more expensive in first cost, soon repays the outlay, owing to the greater facilities obtained thereby for handling the coke. The retort-house is spanned by a light steel roof, the main principals being 72 feet long, with a rise of 17 ft. 6 in. A ventilator 10 feet wide, running the whole length of the roof, provides ample space for the exit of smoke, steam, &c. The total weight of the steel used in building the roof is just under 31 tons; and it is noteworthy that not a single forging has been required in fixing the roof. All the retort-settings are arranged for the introduction of mechanical stoking (manual), and they are also designed with all the latest modern improvements of hydraulic main, gas and tar valves, flushing apparatus, &c.

As space would not permit of the erection of coal-stores on each side of the retort-house—nor, indeed, would the capital invested pay for interest and sinking fund charges on stores, owing to the works being situated so close to the North Staffordshire coalfields—it became a problem how to obtain the best results in "coal trimming," as a large portion of the saving is effected in this direction. It was finally decided to construct two elevator and coal-breaker pits directly underneath the railway lines running along each side of the retort-house; each pit to contain steam-engine, coal-breaker, and elevator, into which the coal is delivered by means of bottom doors in the railway trucks. The elevators each deliver into storage hoppers of 7 tons capacity, fixed in the retort-house, so that either elevator can feed both sides; thus minimizing the chance of a breakdown. The coal is shunted in from the railway sidings; the waggons being run directly over the receiving hoppers. As all the trucks are provided with bottom doors, little difficulty is experienced in emptying the waggons; while with hopper-waggons, built specially for this traffic, hand labour is reduced to a minimum. The receiving hoppers over the coal-breakers are provided with adjustable doors, in order that the supply of coal to the breakers may be regulated according to the size or quantity required. The breakers are driven by a separate steam-engine of the vertical type, which also drives the elevator and conveyor. The elevators consist of 12-inch steel buckets, spaced 18-inch centres, fitted to a strong detachable link chain of cast steel, provided with lugs for fastening bolts and sliding gear; and the buckets are guided by a latticed steel framing, bolted on H steel girders built into the retort-house walls. These elevators are driven by belt and chain gear combined. The belt drive is adopted for the purpose of preventing any damage being done should a piece of iron or other foreign material find its way into the coal-breaker; the belt having a tendency to slip immediately this occurs. After leaving the elevators, the coal is delivered into an overhead storage-hopper or conveyor as required. The conveyor consists of a flat cotton band, kept taut by means of rollers; and it is so arranged that it can be driven by either elevator or overhead hoppers.

The drawing-machine is of the usual rake type, mounted on a triangular frame running on rails laid in front of the charging-machine, and also parallel to the retort-bench. The charging-machine consists principally of a movable hopper carrying about 3 tons of coal, and fixed upon an upright frame running on rails in front of the bench, and, like the drawing-machine, parallel thereto. The charging-machine is provided with steel travelling wheels, cast malleable travelling gear, and rope hoisting gear for raising and lowering the adjustable hoppers to the three tiers of retorts.

For disposing of the coke, movable wrought-iron plates are fitted in front of the retort-bench immediately over the coke-shoots, delivering the coke into side tip-waggons placed underneath. The coke-shoots are carried on brackets bolted to the buckstaves, and are made V-shaped to allow of the men having free access to the clinkering doors. For conveying the coke to the yard, a narrow-gauge tramway, 20-inch gauge, is laid down; and side tip-waggons of 25 cubic feet capacity are used. These waggons will ultimately be hauled out and in by means of an endless rope, although at present they are being worked by hand. For quenching the coke, water-pipes provided with a rose are placed one over each coke-shoot, and also a water-tank of 500 gallons capacity over each line of tram outside in the yard. It is intended that the coke, after being thoroughly cooled, should be tipped into the boot of a coke elevating and breaking machine, broken to size, elevated, screened, and delivered into trucks, or the smaller sizes washed for smiths' use.

The exhausting plant has been completely remodelled; a new engine and exhauster of 50,000 cubic feet per hour capacity having been fixed, and the two existing exhausters coupled up to one engine direct—thus doing away with belt driving. The new exhauster is of the four-blade type; and the engine is controlled by gas and steam governors. A new rotary washer-scrubber, driven by a horizontal steam-engine, has been erected, and is capable of removing the ammonia and other impurities from 1 million cubic feet of gas per 24 hours, and will certainly repay the outlay in the increased yield of residuals. A new station meter has been built, of 50,000 cubic feet per hour capacity, and is erected in an outwardly plain but substantial building, although some little taste has been displayed in the interior decorations, notably the roof, which is stained and varnished. A cabinet of scientific instruments for recording illuminating power and pressure, together with the regulator for controlling the supply of gas to the borough, and a petroleum enrichment plant, make this one of the most interesting places in the works. A new leading main has been laid from the works to the Town Hall, and a new trunk main joined thereon to increase the supply to Dresden and the district.

Another very interesting feature in the works is a small electric light plant, with which the purifying-shed, the governor-house, engine-room, offices, and Manager's rooms are lighted. It is a continuous-current dynamo run at 110 volts, and is capable of supplying sixty 16-candle power incandescent lamps; and it has already proved itself eminently useful in enabling purifiers to be attended to at night, in case of breakdown.

The extensions have cost about £15,000; and the writer considers the money has been well and judiciously expended. He trusts his brief *résumé* may prove interesting to the members.

SOUTHERN ASSOCIATION.

AUTUMN MEETING, NOV. 10.

This Meeting was held at the Holborn Restaurant, under the presidency of Mr. R. Beynon, of Torquay. Compared with the recent meetings, there was a good attendance of members.

The minutes of the previous meeting having been taken as read, the members at once proceeded to the

Election of Office-Bearers.

The President said it was his duty to nominate the President for the ensuing year. He had very great pleasure in proposing Mr. A. E. Broadberry (Tottenham) for this important office. That gentleman was well known to all the members. He was an old member of the Association, and had served on the Committee several times; and he (the President) thought he was in every way suitable for the position.

Mr. C. E. Botley (Hastings) expressed his pleasure in seconding the proposition; and it was unanimously adopted.

Mr. Broadberry, in thanking the members, said he was deeply sensible of the great honour they had done him in electing him President for the ensuing year.

Mr. W. D. Child (Romford) proposed that Mr. D. Irving, of Bristol, be elected the first Vice-President of the Association. He was an old member not only of the Southern, but also of the South-Western Association, and had served on the Council of The Gas Institute; and he (Mr. Child) need not say how zealously and earnestly he worked in every way for the good that might be done by these Associations.

Mr. F. F. Farrand (Ryde) seconded the motion, which was heartily agreed to.

On the motion of Mr. W. J. Hicks (Ascot), seconded by Mr. W. B. Randall (Waltham Cross), Messrs. S. Y. Shoubridge and F. W. Cross were elected members of the Committee.

Mr. Charles Gandon proposed with much pleasure the re-election of their Honorary Secretary and Treasurer—Mr. J. W. Helps, of Croydon; remarking that those of them who had been members as many years as he (Mr. Gandon) had, would recognize the very great service which had been rendered to the Association by Mr. Helps.

Mr. W. A. VALON (Ramsgate) seconded the proposition. The services of the Honorary Secretary had, he said, been such as to fill the members with gratitude; and he for one was personally glad to find Mr. Helps was going to continue in office.

The PRESIDENT thoroughly agreed with the remarks that had fallen from the two preceding speakers. During the nine months that he had been in office, he had found Mr. Helps a valuable aid, and had seen how much he had the affairs and well-being of the Association at heart.

The proposition was cordially agreed to.

On the motion of Mr. F. W. CROSS (Lea Bridge), seconded by Mr. G. W. ANDERSON (Kenley), Messrs. W. H. H. Broadberry and C. E. Botley were elected to the position of Auditors.

NEW MEMBERS.

The following names were added to the roll of the Association: Mr. Chas. F. Botley, of Hastings; Mr. J. Dougall, of Margate; Mr. William Littlewood, of Tiverton; and Mr. John Young, of Norwich.

THE LATE MR. ROBERT HUNTER.

The PRESIDENT said there was one matter which he desired to bring before the members at this stage. They were all aware that the gas world had of late suffered a loss by the death of Mr. Robert Hunter, of Chester; and in the last issue of the *Journal of Gas Lighting* it was announced that his family were very badly provided for. The matter had come before the Committee; and the result was that he had now to propose that the Association subscribe £5 5s. towards the fund which had been started on behalf of the widow and family of the late Mr. Hunter. They had very deep sympathy with them in their distress; and what the Association were doing as a body need not debar any member subscribing individually to the fund.

Mr. CHILD seconded the motion, which was passed at once.

Mr. C. E. BOTLEY (Hastings) then read the following paper, describing

EXTENDED EXPERIENCE WITH THE HASTINGS CARBURATION PROCESS, FOR THE PREVENTION OF NAPHTHALENE DEPOSITS IN THE DISTRIBUTING MAINS AND SERVICES.

At the request of the Committee, I have consented to bring before this meeting, the further and extended experience we have had at Hastings with the carburation process for the prevention of naphthalene deposits in the mains and service-pipes during the distribution of the gas over the whole canalization.

It will be remembered that a paper on the subject was read before the Institution of Gas Engineers at their May meeting in 1897, when a full account of the naphthalene difficulties at Hastings was presented, and a complete statement given of the various means tried with a view of curing them—all of which had proved failures until this system of carburation had been invented. The effect which this system had had in reducing naphthalene stoppages to an enormous extent was then fully described; but criticism was directed to the possibility of the results achieved being fallacious, owing to the time over which the carburation had been employed—viz., sixteen or seventeen months—being considered too short. This contention was not accepted at all by the authors; and the further experience since gained shows their belief to have been well founded.

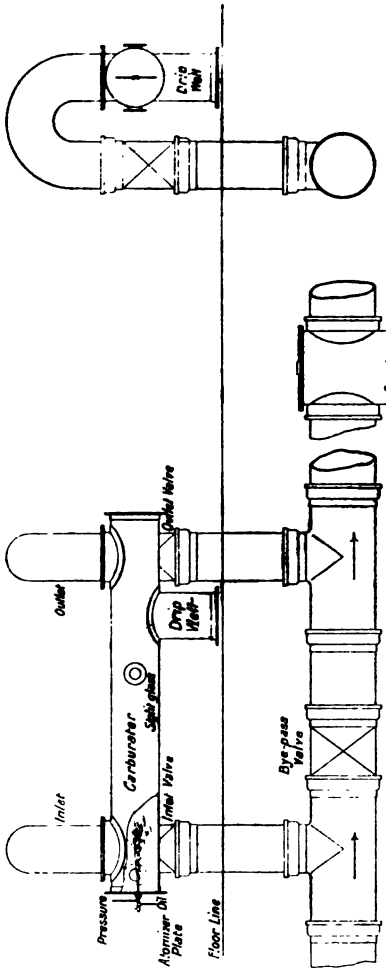
It may here be well to briefly describe the process, as some present may be unacquainted with it. It is the treatment of the gas going into the district from the outlet of the governors, by adding an oil mist to it, enveloping the gas in an oily atmosphere, through which it is protected throughout its canalization whence it passes on to the burners. This atmosphere, or mist, or fog, is produced by mechanically breaking up a hydrocarbon oil (non-volatile at ordinary temperature) into minute atoms, so finely divided that the mist thus created will float away in the air like smoke from a cigar, and yet have an oily humidity. The production of this oily mist and its application to the gas at the point named is accomplished as follows:—A shunt or bye-pass main, with the necessary valves, is fixed on the outlet main from the governor, at one end of which atomizers of special make are placed, and suitable means provided for observing their correct action. A compressing-engine draws gas from the main, and compresses it in a cylinder to a pressure of about 75 lbs. per square inch. This compressed gas is used for two purposes, at a reduced pressure of 25 lbs.—first, to force oil from a cylinder to the atomizers; and, secondly, to supply force at the same point to split the oil up and form the mist. One or more atomizers are used as required, according to the flow of gas. The working is quite automatic otherwise, and can be applied to as many outlet-mains as required with the same compressing plant.

It will now be interesting to record the action of carburation in this manner, as experienced at Hastings. When the system was started, the mains and services were largely charged with naphthalene, which was reduced or increased according to the temperature, but never wholly absent. After the process had been started a month or two, the naphthalene found was much softer, and had an oily appearance. Then, as this gradually disappeared, oil in very minute quantities was found in the governors of the public lamps, which caused a little trouble, but was of very slight consequence compared with the naphthalene stoppages. When this had been carried on for a considerable time, the quantity of hydrocarbon oil turned into mist was reduced very considerably, and an examination of the mains in various parts of the district showed they were clean; so that, with all vicissitudes of weather and temperature, it was found that 1 gallon of hydrocarbon only was required for every 166,000 cubic feet of gas to keep clear of naphthalene. The cost of this, including all charges, was 0·100d. per 1000 cubic feet of gas sold, or 1d. per ton of coal carbonized. Full particulars and the details will be found in the *Journal of Gas Lighting* of July 26 this year (p. 202), which included the figures to the end of 1897; and the results thus obtained were more than sustained up to the time of stopping the plant for general repairs to the engine, &c., on Aug. 15 of this year. These results I have diagrammatically illustrated.

It is here necessary to mention that carburetted water gas had been introduced, and the proportion added had been gradually increased. Up to the end of 1897, it was only 8 per cent. for the year; but during this year it has been about 20 per cent. The author has contended that carburetted water gas is no remedy for naphthalene directly, though indirectly, of course, it does help; as if you are using 20 per cent. of a gas depositing no naphthalene in distribution, you have that much less to deal with in the total gas. Opportunity was therefore taken of the stoppage of the carburation process to try the effect of distributing the mixed gas as regards naphthalene deposits. The plant had hardly been stopped a week, when one or two small lights were noticed in some duplex burner public lamps which had originally given trouble, and which had the hole in the plug of the burner-cocks rather smaller than usual. These failures were reported to me as being caused by naphthalene; but the cocks were cleaned and tried again. In a day or two the same thing occurred. One of the cocks was then taken off, and brought in for examination, which proved conclusively that the cause was our old bugbear—this light flaky naphthalene just covering over the gas-way in the cocks.

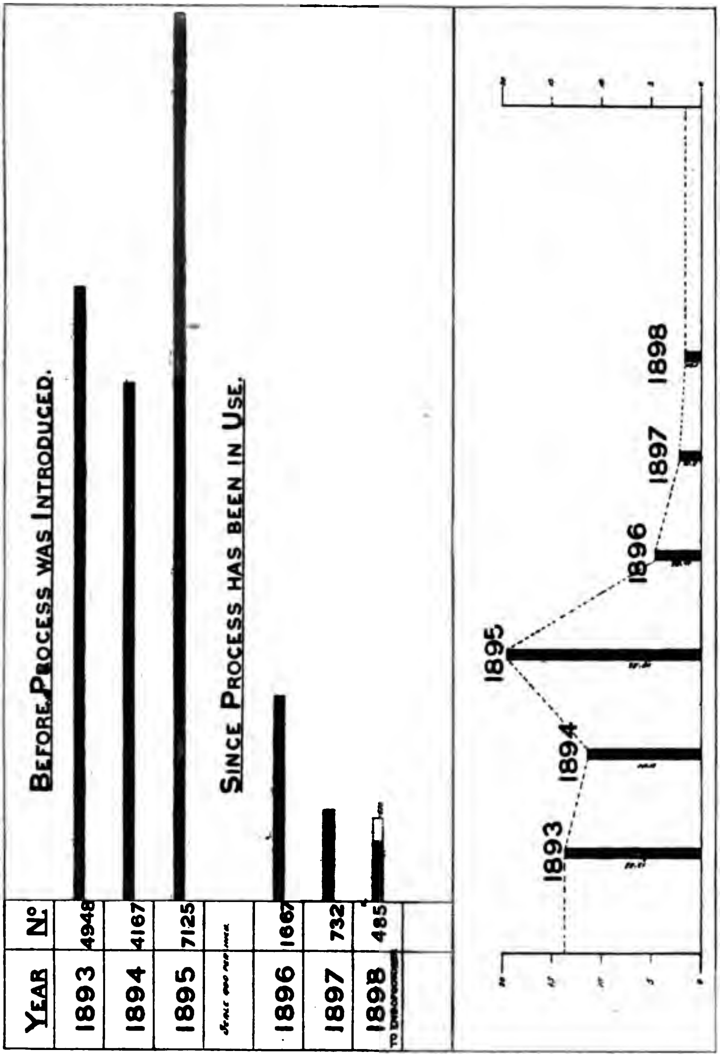
As we did not have any complaints from house services in the district, we let the experiment go on. But we gradually got a few complaints again; and an examination showed that the naphthalene had begun to find its way into the services, while the

FIGS. 22 TO 25.—DIAGRAMS REFERRING TO THE CARBURATION PROCESS AT THE HASTINGS GAS-WORKS.



GENERAL ARRANGEMENT OF THE PLANT.

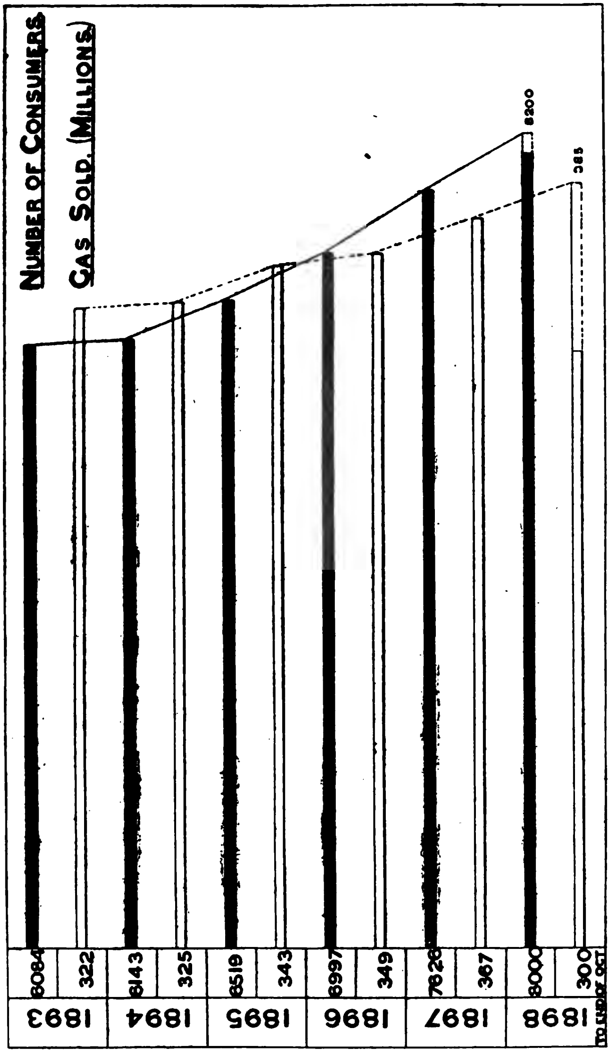
outdoor foremen concerned wished to get the carburation plant on again, so as to save the increasing number of complaints. The stopping and re-starting of the apparatus has, however, given opportunity of again following the action of the carburation on the naphthalene; and the observations made confirm this action as originally observed.



TOTAL NUMBER OF STOPPAGES PER ANNUM, AND AVERAGE NUMBER PER DAY.

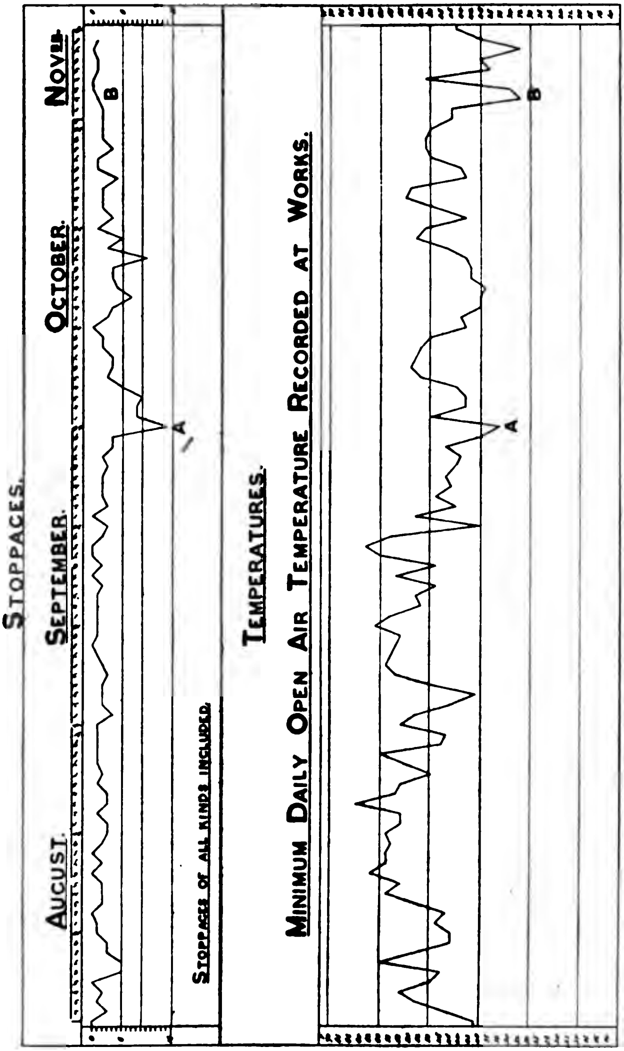
Although the apparatus was only stopped for seven or eight weeks, investigation of the mains and services showed that naphthalene had again begun to collect; and the first action of the carburation was to apply it in such a manner that the deposits were moistened with the oil mist and gradually loosened and dispersed, and positive proof was furnished that this naphthalene was to some extent taken along with the gas to the burner and there consumed. The public lamps presenting least resistance to the flow of the gas naturally proved this the

INCREASED NUMBER OF CONSUMERS AND QUANTITY OF GAS SOLD.



Scales.—Consumers, 500 per ¼ inch; gas sold, 25 millions per ¼ inch.

most. Observation has shown that the amount of condensation found in the street syphons is, if anything, more in quantity; but it is partly of an oily nature, and of a most pungent



Naphthalene and Temperature Diagram, Aug. 1 to Nov. 9, 1898.

AA. Effect of sudden drop in temperature, process not in use.
BB. " " process in use.

smell, which entails the necessity of pumping it into a small tank and bringing it back to the works, where it is disposed of by mixing it with the coal to be carbonized.

It may be interesting to state that it takes about a fortnight in cold weather for the oil mist to spread through the whole canalization of about 90 miles, when it can be plainly seen on opening a lamp-cock or taking a plug out of the main. It should also be mentioned that a considerable quantity of water is deposited at the point where the gas is first of all treated, which is drawn off from the syphon on the 24-inch separating main. During the whole time that the process has been at work at Hastings, the same description of coal has been in use, and no alteration has been made in the manufacturing plant; the only change made being the gradual increase in the quantity of carburetted water gas mixed with the coal gas. Another matter noticed, which is of considerable importance, is that the carburation process protects the gas right up to the dead ends of the mains in all directions, so that the illuminating value is better maintained up to these points. The importance of this is more apparent in a place like Hastings, or any other seaside town where there are long lengths of main with dead ends, than in inland towns where the mains can all be connected up together.

The cost of applying the carburater and necessary apparatus to a 24-inch main would be about £300 or less; and the extra cost for each additional main connected to the same apparatus would be about £100 or less. It is hardly necessary to point out that the cost of the apparatus and of the working is paid for over and over again by the saving effected in the labour in clearing the services, besides avoiding the annoyance to consumers, and the mitigating effect on the using of gas appliances generally, owing to the uncertainty engendered when these stoppages occur.

The theory that has been considered as the most probable one to account for the action of the carburation process in preventing the forming of naphthalene deposits is that an artificial vapour tension is created, and that the naphthalene contained in the gas is mostly taken to the burner and consumed; but that if any should leave the gas it cannot crystallize—*i.e.*, deposit in a solid form—in the presence of the oil mist, but simply falls and is carried into the syphons with other condensation. This accords very much with the remarks made in the discussion at the meeting of the Institution of Gas Engineers when the paper was read.

Calling attention to the diagrams during and after the reading of the paper, the author pointed out that in 1893, before the process was adopted, the number of stoppages per annum was 4948, and in 1895 they had risen to 7125. The first year after the process was in use (1896), the number was reduced to 1667, falling to 732 in 1897, and to 485 in 1898, to the end of October. This point was as low as he could hope to attain to. In 1893, the number of consumers was 6084; and the gas sold was 322 million cubic feet. In 1897, the figures were 7626 consumers and 367 million cubic feet; while up to the end of October this year, they were 8000 and 300 respectively. Although the consumers had increased so very much, the rate of stoppages was reduced to quite a minimum now. Incidentally, this illustrated another point—that was the result of introducing prepayment meters. The diagram indicating the number of consumers and the quantity of gas sold showed that the gas sold corresponded, up to a certain point, fairly well with the number of consumers. Since they had taken on prepayment consumers, the lines did not so correspond. The consumers had overlapped the gas sold—showing that, although they had a larger number of consumers, owing to the prepayment meters and the incandescent lighting, the quantity of gas had been reduced proportionally very considerably. Directing attention to the naphthalene and temperature diagram, the author said this was perhaps the most interesting. The line in the upper part of the diagram showed the number of stoppages of all kinds since Aug. 1 up to that very morning. It would be seen that, when the apparatus was stopped, the increase in the naphthalene corresponded with the fall in the temperature. When the sudden fall in temperature occurred on Sept. 30, the stoppages at once increased. After the apparatus was at work again, there was, on Nov. 2, a similar drop in temperature; but the line showing the stoppages was maintained practically level—they had no increase whatever. This showed very strongly—in fact, it conclusively proved—as he had contended all along, that the process did prevent the stoppages occurring under similar conditions of rise and fall of temperature.

Discussion.

Mr. J. W. Helps (Croydon) said that, as Mr. Botley had mentioned in the early part of the paper, it had been considered by some that, at the time he brought his paper before the Institution of Gas Engineers, a sufficient period had not elapsed to give the process a fair trial. He (Mr. Helps) was perhaps responsible for a remark to this effect at the meeting of the Institution. However, after a considerable lapse of time, Mr. Botley now presented them with his further experience; and he (Mr. Helps) thought he had practically proved his case—that what he had been doing with this process had, to a very great extent, abolished the naphthalene bugbear. It was naturally very difficult in discussing the paper to speak of it any way but from the naphthalene standpoint; and it would be difficult for those who did speak not to wander a little from the path. It was evident that at Hastings Mr. Botley must be accomplishing his successful methods in one of three ways: Either he must, in his process of manufacture and purification at the works, be treating his gas in such a way that he did not make naphthalene; or he deposited it on the works; or he must, by his process, be doing something that either prevented the naphthalene falling out, or, if it did fall out, some hydrocarbon dropped out in the liquid form, dissolved the naphthalene, and carried it forward to the syphons. He (the speaker) was not an agnostic; he did not believe in those who stated that they did not believe in anything they did not understand. At the same time, he thought it was the duty of every man who accomplished something to look into what he had accomplished, and try to find out the reason for his faith; and what he had to find fault with in this case was that Mr. Botley had not so far given to gas engineers any very good theory as to the way in which the process produced the results. He told them, in perhaps the most interesting portion of his paper, that they were brought about by creating an artificial vapour tension, which was something he, for one, did not understand; and he hoped that Mr. Browne would have a word to say on this point. Anyone who followed the interesting discussion that took place between Mr. Browne and Mr. William Young* would, he thought, have come to the conclusion that it was almost impossible, by the addition of any hydrocarbon to gas, to so alter the average vapour tension as to prevent the deposition of naphthalene. Now, Mr. Botley had, in his paper, practically made a comparison between the effects produced on naphthalene by the use of the process and by the use of water gas. In what he (Mr. Helps) was going to say, it might perhaps be considered that he was giving away certain secrets, and he might be looked upon, therefore, as somewhat of a heretic. In Croydon, they had for the past nine or ten months been using a large proportion of water gas. He might say that, when they commenced supplying water gas, the results were so very pleasing that he thought they had discovered something which would for ever do away with the naphthalene bugbear. Here he would point out that Mr. Botley, in describing the last diagram, stated that he found the number of complaints of stoppage had a distinct ratio to the drop in the temperature. Now, this was not, he (Mr. Helps) must say most distinctly, his experience. He found—and he had taken pains to get out figures to prove what he was asserting—that it was not so much the lowest point of temperature experienced during the 24 hours that caused the deposition of naphthalene, as the difference between the highest and the lowest temperatures. He would first refer to the figures for the month of January, when probably the lowest temperature was experienced; at any rate, it was much lower than later on in the year. He found in January, 1897, the difference in the shade temperature throughout a day (he had averaged it over a week) amounted to 7·7°; and during that month they had a weekly average of 32 complaints. In the same month this year, they had an average difference in the temperature of 10·6°; and they had a weekly average of 45 complaints. Then he passed on from January (which might be taken as a fairly typical month) to July. In that month, they recorded an average difference in temperature of 22·6°; and the average weekly complaints rose to 194. The same month this year, the average difference of temperatute was 22·3°; and the number of complaints had averaged 201 weekly. These corresponded fairly well when the increased number of consumers was taken into account. In August, 1897, the average difference was 19·3°, with a weekly average of 145 complaints. This year, in August, 21·2° represented the difference in temperature; and they had 189 complaints. In September this year, as they all knew, the difference of temperature was very great. He was not only talking of the shade temperature, but the sun temperature was so high that the gas in the holders was heated enormously, but was no doubt quickly cooled again when it reached the mains. The difference in temperature in September, 1897, was 15°, with a weekly average of 96 complaints. In the same month this year, the difference of temperature was 22·4°, and a weekly average of 235 complaints. This was a sad state of affairs to speak of as happening in connection with what he looked upon as a fairly well-managed Company. (Laughter.) But he knew it was more by their failures than by their successes that they hoped to learn and arrive at the goal they were all striving for. He believed, when the members came to look at these figures, they would find that the number of complaints bore a ratio to the difference between the average highest and the lowest temperatures during a week or day as the case might be. As to water gas, at Croydon they put 25 to 30 per cent. into a cylinder which was common to the inlets of the holders. He took it, in the light of what appeared in the discussion between Mr. Browne and Mr. Young, that the coal gas as it entered the holders was, at the temperature at which it then existed, practically saturated with naphthalene. The addition of from 25 to 30 per cent. of water gas practically formed a compound, which in itself—water gas containing no naphthalene—was in an unsaturated condition; and in this condition the mixed gas passed on to the holder. In very hot weather (being heated up in the holder to a considerable extent), as it left, it came in contact with the previous depositions of naphthalene, and undoubtedly it picked up a large quantity. And so at this high temperature (he might say above 100°) it issued in an unsaturated condition; and in this state it went out into the town. What happened? Was it possible to cool steam down below a certain temperature without reducing it to water? Was it possible to cool gas saturated with naphthalene without the naphthalene dropping out in some form or another? He said "No," distinctly. They might have the day temperature very high and the night temperature low; and it seemed to him impossible, by the use of water gas, to prevent the deposition of naphthalene. If they were to put the water gas on the outlet of the holder, they would make the mixing a much more difficult matter; and then it was quite possible they would send out a gas in an unsaturated condition, which would pick up any naphthalene already deposited. In winter, when the holders contained gas in a cooler condition than it might be in the mains, it was quite possible then for an absolutely opposite effect to be produced. The gas itself came out cool, and became heated in the town; and consequently, by the heating, it was raised to a condition in which it was unsaturated. He thought that one remark might prove this. During the hot weather, when the gas was tested at the works they would find that the illuminating power was (say) 15¾ candles; and if it was tested two miles from the works, it would be found to be 15½ candles. In cold weather, when the gas in the holder was cooler than in the mains, they would find the opposite; it might be only 15½ candles at the works and 15¾ candles a distance away. He thought this was a fairly distinct proof that there was something in what he was asserting; and he could not help thinking that Mr. Botley even now had not got to the true reason for the results he had obtained. If he (Mr. Helps) might be allowed, he would suggest just one little point. Mr. Young, in his arguments with Mr. Browne, practically stated that the deposition of aqueous vapour from the gas really had nothing to do with the deposition of naphthalene in the mains. It was possible perhaps that, from the chemical point of view, it might have nothing to do with it; but, from a mechanical point of view it had, in his (Mr. Helps's) opinion, a great deal to do with it. He believed Mr. Botley had said that in his process he found, almost immediately after the mixing cylinder, a considerable deposition of aqueous vapour. Was it not quite possible that, at the exact moment that this aqueous vapour was thrown down, this fine mist or fog really took the place previously occupied by the water vapour? The result was that this oil vapour would not be thrown down by the cooling of the gas afterwards in the mains, and the mechanical effect caused by the deposition of what would be otherwise aqueous vapour was prevented from acting on the gas so as to produce the naphthalene deposits. He thought that those who had suffered (as gas engineers had done in London during the past summer) from an immense number of naphthalene complaints would adopt this process if Mr. Botley would prove to them that he had (as he bid fair to prove) found out a means by which they would be saved further difficulty.

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* See *Journal of Gas Lighting*, Vol. LXVIII., pp. 320, 419, 598, 647, 795, 910.

Mr. A. F. **Browne** (Rotherhithe), called upon by the President, said that unfortunately he arrived when the paper had been partially read; and this placed him at some disadvantage. He did not feel he had much to say on the subject of naphthalene when he entered the room. He thought he gave some of them an overdose of it a few years ago, even if he did not take one himself. Mr. Helps' remarks had practically covered the whole ground; but the more he (Mr. Browne) heard of the process of Mr. Botley, the more it appeared to him that he had proved his case. Theory was one thing; practice another. Mr. Helps had rather fallen foul of Mr. Botley, because he had not been able to produce a theory which was satisfactory to everybody. He thought perhaps Mr. Botley would say he had not produced a theory that was satisfactory to himself. That was probably a very difficult thing to do; and he did not think they ought to quarrel with a process because they did not know how it was done. They were, of course, anxious to know, and would be glad if some day the whole method was made clear to their understanding. He thought, however, that all Mr. Helps had contributed to the discussion with regard to the probable causes of these effects was very interesting, and very likely it might be true. As to Mr. Botley's statement that, at the point where the oil was atomized into the gas, there was constantly found a considerable deposit of water, this struck him (Mr. Browne) as a notable fact. Mr. Helps had, he thought, followed that up all right, and had drawn from it the same conclusion that he (Mr. Browne) would have been disposed to draw from it—that, in some way or other, a gas which was carrying one liquid in a very finely divided form was unable to carry two at the same time. It dropped one to take up the oil mist, and the oil mist acted probably mechanically, and, being in a very fine state of division, had an extraordinary vitality (so to speak) in its travel in the gas. He believed he understood Mr. Botley to say he found the light vapour maintaining itself in the gas even at the remotest ends of his mains. This being so, they must admit that the light vapour had an astonishing vitality; and it seemed to him, failing a better theory (and he thought he was practically repeating what Mr. Helps had already said), that, in some way or other, this light oil carried the naphthalene. He also agreed with what Mr. Helps had said as to the result of the correspondence he (Mr. Browne) had a few years ago with that great authority on this matter, Mr. Young. It did appear to him that somehow this light oil mist was able mechanically to carry these small particles of naphthalene—partially, he supposed, they were dissolved. They would very naturally suppose that, if the minute drops of oil dissolved up naphthalene, they would fall; some would fall, and some would survive. The process, however, had most certainly delivered Hastings from the naphthalene nuisance. Mr. Botley had applied the best experience to the other side of the question. For a certain period, he told them, in order to put the matter to the test, he discontinued the process of atomizing the oil into the gas, and thereupon the complaints began to increase in number. That being so, they need hardly be surprised that Mr. Botley cut the experiment short; but perhaps he would try it again at another time. He did not think they ought to grudge Mr. Botley their admiration and approbation of his scheme. It was perfectly true that it might be that he did not now produce the naphthalene at his works, even if he produced it before. They could not settle that question—it was impossible. He, however, believed the success of the process was established; and he could heartily congratulate Mr. Botley upon that success. He was not surprised that he had been unable to find a theory that would put the method of its working beyond a doubt. Like Mr. Helps, he (Mr. Browne) did not quite understand what was meant by an artificial vapour tension being created. He had not studied naphthalene much lately, though he had had more than usual on his works.

Mr. A. E. **Broadberry** (Tottenham) remarked that, when he first saw the process at Hastings, he was struck with the fact that there was a large quantity of water deposited in the syphon; and it had occurred to him that this did justify Mr. Botley in making the claim he did for his apparatus. With regard to carburetted water gas, Mr. Helps had dealt with that pretty fully. At Tottenham, they had certainly found more advantage from carburetted water gas than either Mr. Helps or Mr. Botley had done.

Mr. Helps: You use more of it.

Mr. Broadberry said that probably it was due to the fact that these gentlemen sent out carburetted water gas in the proportion of 1 to 3; while at Tottenham they sent it out in the proportion of 1 to 1. There was one other point in the paper which neither Mr. Helps nor Mr. Browne had mentioned. He saw that Mr. Botley dealt with the gas at the outlets of the governors. It would be interesting if he would tell them whether he had come to the conclusion that it was not applicable on the inlet of the governor. The pressure at which the oil was injected—75 lbs. per square inch—was so high that surely it could not make any difference, with two or three inches variation in the pressure of the gas, whether it was on the inlet or outlet of the governor.

Mr. C. F. Botley (Hastings) said, in making a few remarks, he would endeavour somewhat to relieve his chief by replying to some of the remarks already made. First of all, he should like to make clear the point raised by the last speaker. The only object in putting the apparatus on the outlet of the governor was this—that excessive friction meant an excessive deposition of oil from the gas when it was supersaturated. At certain hours of the day the consumption of gas varied wonderfully. At one hour at Hastings it might perhaps be as high as 210,000 cubic feet; while at another it might be down to about 15,000 or 20,000 cubic feet. They did not want to be "fiddling" about with the atomizers all the time; and so they simply set the apparatus and allowed it to go on. The consequence was they got supersaturated gas, and this they partly recovered with the water in the syphons upon the main. They always had a certain amount of water in the syphons; and they afterwards separated the oil from the water. Up to a certain specific gravity, the oil was used over again. This he thought would answer what Mr. Broadberry had asked. It had nothing whatever to do with pressure, though it was better to work with the town pressure than the holder pressure; and the process could be applied anywhere they pleased. Now, looking at the paper that was read before the Institution of Gas Engineers, it would be found stated there that carburated gas would not carry water, which was possibly a powerful clue to the action on naphthalene. The words in the paper were: "Carburated gas is permanent under ordinary conditions, and will pass through water without alteration. This is probably a clue to its powerful effect on naphthalene, in the formation of which moisture is an important agent." He was perfectly well aware that this had been much questioned by an authority with whom he would not wish to class himself; but at the same time, from his (Mr. Botley's) experience, he believed it to be true. "Carburated gas will not apparently carry water any more than oil-sheets will absorb water." This was what was written in the Institution paper; and it showed that the point as far as water was concerned had been dealt with. Now he came to the question of the highest and lowest temperature; and he thought Mr. Helps must have rather misunderstood the paper. The point in the diagram which showed a sudden rise in the number of stoppages had been referred to as being the actual result of a drop in temperature; and he believed Mr. Helps would find in this case that it was quite independent of the difference in the mean temperature or cold. It would be seen that the apparatus was off in one case of a sudden drop in temperature, and on in another; and the diagram was really got out to show that, when the apparatus was in operation, fluctuation in temperature did not affect the results. When it was not in use, the effect was seen upon the diagram. As regarded naphthalene on the works, he need scarcely assure Mr. Browne that there was no difference in this respect. They produced naphthalene on the works practically the same as they had always done. But they knew perfectly well that, if they did not use the apparatus, or if they did not use it efficiently, they got naphthalene all over the town. This was to his mind sufficient proof of its utility. With other things to do, he could not go looking about for a theory when he was relieved of all difficulty by merely keeping this simple apparatus at work. If Mr. Helps would only give him the opportunity, he should be pleased to show what could be done with the apparatus at Croydon.

Mr. S. W. Durkin (Southampton), in response to a call from the President, said he was not in a position to discuss Mr. Botley's paper; but on the general question of naphthalene, he might say it was a difficulty which he had not yet been able to overcome. If Mr. Botley's system was so successful at Hastings, he did not at all see why it should not be tried elsewhere, so as to ascertain if it would get rid of the horrid naphthalene nuisance under varied conditions. He had noticed that, in certain parts of his district, there was a deposition of naphthalene in the mains, which appeared to him to arise after the gas had deposited a certain amount of moisture. But in mains going out five or six miles from the works, they got very little, as a rule; so that apparently a drying process went on which prevented the deposition of naphthalene. If this process tended to hold the naphthalene in suspension and carry it on, so much the better for the illuminating power of the gas. He hoped that some other engineer would take up this process, and try it in a different district to Hastings. He might add that, when the temperature varied very rapidly after a warm day, he found that the naphthalene trouble came on very quickly. It had been so more or less all the summer, because they had had some very wintry nights; and he attributed the difficulty to decrease in the temperature bringing on the deposition, especially in the public lamps.

Mr. R. P. **Thomas** (Ware) said managers of small works could scarcely hope that their Directors would spend £400 or £500 on an apparatus of this kind in order to deliver their managers from the naphthalene difficulty. Stoppages of service-pipes had been his trouble for years, especially in cold winters. He did not have much trouble last winter; but there had been times when he had had 43 lamps stopped out of 140. The best remedy he had found for dealing with the stoppages, both in public lamps and consumers' services, was simply to remove the tap and pour in ½ gill of naphtha. They were much indebted to Mr. Botley for his paper; and the only question he had to ask him was as to the class of coal he used.

Mr. W. H. H. **Broadberry** (Tottenham), having congratulated Mr. Botley on the progress he had made with his invention, said this question of naphthalene had always been a bugbear; but he hoped it would not continue so. For the last 45 years, he had been troubled more or less with it in one shape or another. At one time, gas engineers were satisfied if they made something like 8500 cubic feet of gas per ton of coal. Then they did not know what naphthalene was. By-and-bye, however, they had to make 9000 cubic feet per ton, then 9500, 10,000, 10,500, and so on, with the result that they had naphthalene in all directions. He understood Mr. Botley to say that he used petroleum. They all knew that for years past naphtha had been spoken of as a remedy for stoppages. He remembered a paper being read before one of the societies in which the author recommended the sprinkling of each tier of the purifiers with naphtha. He

(Mr. Broadberry) was silly enough to try it. For the first few days after starting the purifiers, they did not have very much naphthalene; but afterwards they had as much trouble as ever. He agreed with Mr. Helps that the deposition of naphthalene in the mains had more to do with the variation of temperature from day to night than anything else. Before they adopted the water-gas process at Tottenham, they were troubled with just as much naphthalene as anybody ought to be. But on water gas being used, the naphthalene began to clear away; and practically they had had no trouble since. A short time ago, they were annoyed with a deposition in the pipes that looked very much like naphthalene; and they thought it was. They had formerly been using Russian oil, but had got away to the American oil. With the latter oil they had been working at the same heats as with the Russian oil; and they found that it would not do. The trouble they had was not naphthalene; and, on altering the heats in the saturator, they found that the difficulty ceased. They had lately been relaying 40 or 50 feet of 2-inch pipe with 4-inch; and in the 2-inch pipe they had had frequent stoppages. They had always given naphthalene the credit for this; and so, when they took up the pipe, they carefully disconnected it, with the result that they found some very fine iron rust had collected in it. Since the 4-inch pipe had been down, they had not had any trouble. He was very pleased with Mr. Botley's apparatus; and he hoped that, by the next time the author read a paper on the subject, he would have made a perfect apparatus of it, if not already so.

The PRESIDENT said he did not think he could amplify any of the remarks that had been made; the ground seemed to have been covered most thoroughly. There was one question he should like to ask, and that was as to the state of the naphthalene question at Hastings before Mr. Botley put his process in —whether he got naphthalene in all districts alike, or suffered from it in some places and not in others. At Torquay, they had houses from which they had not had a single complaint ever since he had been there, no matter what the temperature might be; while the adjoining houses were continually suffering, and the Gas Company's man had to blow out the pipes perhaps once a week. Mr. Botley deserved a great deal of credit for having produced this process. He (the President) had been down to Hastings, and seen it at work; and it seemed to have met with great success there in doing away with complaints. The question had exercised him as to whether he should adopt it at Torquay to get rid of the naphthalene nuisance there.

Mr. **Botley**, in reply, said he was very pleased with the tone the discussion had taken. Mr. Helps, who described himself as his great antagonist, though he (Mr. Botley) did not look on him as such, had raised a number of questions; but to some extent he had been treading on ground which was covered in the paper read before the Institution of Gas Engineers. The same arguments that he had now used were considered at that time. He (Mr. Botley) was told that he advanced no theory as to what occurred in this process. Mr. Browne had to a certain extent answered that for him. It was most difficult to raise a theory in a matter of this kind. The question had given him a great deal of thought and consideration. His son and himself had discussed it, and had tried to discover what really took place; and to the best of their belief that which did occur was what was stated in the paper. With regard to the remarks which had been made as to the term "artificial vapour tension," there was a possibility, he thought, of the vapour tension being artificially increased. A question had been put as to whether there was any alteration in the naphthalene on the works. They had never had much trouble there with naphthalene. It had not increased; it was exactly the same. They did get naphthalene upon the works, and had to clear out the apparatus periodically; but they had no particular trouble, as they looked after it in time. Mr. Browne's suggestion that they did not produce naphthalene was covered by that statement. They used the same description of coal now, worked at the same heats, and practically sold the same quantity of gas per ton of coal carbonized, as formerly. For the last thirty years they had used New Pelton and Pelaw Main coals. These coals in working did produce naphthalene; but they were good coals in all other respects.

Mr. **Browne** remarked that he had not suggested that Mr. Botley did not produce naphthalene on his works.

Mr. **Botley** said he understood Mr. Browne to say that there was the possibility that at the present time they were not producing naphthalene. In regard to Mr. Durkin's remarks, if the gas had a long way to travel in the pipes, and naphthalene had been deposited for some distance, of course at the extreme ends they would find none. One point which he hoped was noticed in the paper was this: By enveloping the gas with an oil mist, they carried the illuminating value of the gas right to the end of the district. There was no question about that—in fact, the improvement in the light at the far ends of their area had been commented upon. In the old days, before the adoption of the process, the gas had been very thin sometimes at the extreme ends; but now it looked as good there as it did close to the works. Mr. Thomas had raised a question about the cost of an apparatus of this kind. He had given the cost of applying the process to a 24-inch main; but if it was only for a 6-inch main a very simple thing would accomplish the same purpose. He might mention that, although they had naturally protected themselves in regard to this process, the patent had not been taken out with the view of making a lot of money. He could not say anything fairer than this: That he would give anyone present permission to try the process by arrangement with him, so as to see for himself what the results were. Mr. Broadberry had spoken of the formation of naphthalene being largely owing to increased heats. This was no doubt the case. Now they had to get all they could out of the coal, which they would not do if they worked at the old temperature. With regard to the oil employed in the process, they used the ordinary tea-rose oil of commerce, which could be bought at 6d. per gallon. The President asked whether he had had districts in which there was not any naphthalene before the process was started. He could answer that in the negative. His experience was like that of the President—that the action of naphthalene was most erratic. As to particular houses suffering more from naphthalene than others, from what he had been able to gather he had come to the conclusion that it was merely due to the extra facility afforded by one pipe over another for naphthalene passing in. He was satisfied that what had been accomplished at Hastings anybody could effect by the same means.

Mr. W. B. **Randall** (Waltham Cross) read the following paper

LOCALIZING LEAKAGES.

The subject of localizing leakages will occur to most gas engineers in the routine of business, being so closely allied to that "Will-o'-the-wisp" unaccounted-for gas, which so largely determines the success of gas undertakings. Dividends are truly said to be made or lost in the retort-house; but, according to the annual Parliamentary Returns, it must be conceded that in many cases good manufacturing results are marred by a weak distribution system, and the dividend thereby lessened.

I do not propose to quote statistics on the amount of leakage, &c., as they are already well known, but simply to submit a method of localizing leakages which I have found to be both economical and satisfactory. The usual plan pursued in testing distributing mains, services, &c., is to take a length of main, &c.,

drill holes, and insert bladders at both ends; then connect up with a testing-meter, and note the amount passing through the meter to supply the main under observation. One bladder at each end is not reliable, as they are apt to pass a certain amount of gas and spoil the value of the test. The safer method is to have two bladders close together, filling the space between them with water from a short stand-pipe; or to cut out and plug off the main at each end, having first shut off all main taps, lantern cocks, &c., on the particular length under observation. Another method is to have syphons which, by means of a diaphragm or midfeather, reach within a few inches of the bottom of the box, which can be sealed by water, and so ensure gas only passing by the midfeather through the arranged connections and meter.

The principal objection to these methods is that they are liable to cause a certain amount of inconvenience to consumers, through having to shut off their main tap during the tests. Also that in bladdering and meter connections considerable time and labour are expended, and the main weakened by the necessary holes. Again, the main taps and lantern cocks may bye-pass or leak; and after ascertaining the exact amount of leakage, the actual source remains to be discovered.

These objections do not exist in the following system, which depends upon using a leakage indicator. This consists of a porous diaphragm, through which any mixture of gas and air can percolate, and which is so arranged that the percentage volumes are indicated by a pointer on a graduated dial. The instrument operates through the well-known law of diffusion of gases—viz., the velocity of diffusion of gases is inversely proportional to the square roots of their densities. Thus four volumes of hydrogen will pass through the diaphragm in the same time as one volume of oxygen is able to do—oxygen being sixteen times as heavy as hydrogen.

In the case of a district where plans, notes, or records are not obtainable as to the size and position of the gas-mains, Ordnance maps are procured, and copies of the thoroughfares are transferred on an enlarged scale to a suitably ruled note-book. All new mains when laid are duly noted as to their sizes, position, &c., and a plan and section of the ground, showing the main, is made as required. The service layers also note the depth and position of the main whenever they excavate to lay or repair a service; and as other opportunities occur—such as excavations to sewers or water-pipes—notes are made of the same and duly recorded.

TABLE REFERRED TO IN MR. W. B. RANDALL'S PAPER ON "LOCALIZING LEAKAGES."

Year and Quarter.	Half Year.	Gas Made.	Gas Sold.	Used on Works.	Leakage.		Gas Made Per Ton.	Gas Sold Per Ton.	Miles of Main.	Number of Consumers.
1892.		Cub. Ft.	Cub. Ft.	Cub. Ft.	Cub. Ft.	Per Ct.	Cub. Ft.	Cub. Ft.		
Michaelmas .	..	4,498,800	3,253,500	..	1,245,300	27·03	10,684	7,727	..	
Christmas .	..	8,846,400	7,890,900	..	955,500	10·79	10,645	9,495	..	
	Dec. 31	13,345,200	11,144,400	..	2,200,800	16·48	10,671	8,901	15	500 250 P.L.
1893.										
Lady-day. .	..	7,714,500	6,910,100	..	804,400	10·42	10,570	9,469	..	
Midsummer .	..	4,319,800	3,469,700	..	850,100	19·67	10,664	8,567	..	
	June 30	12,034,300	10,379,800	..	1,654,500	13·75	11,094	9,569	..	
Michaelmas .	..	4,805,800	3,789,900	47,000	968,900	20·01	10,562	8,329	..	
Christmas .	..	9,022,500	8,348,000	93,000	581,500	6·44	10,334	9,562	..	
	Dec. 31	13,828,300	12,137,900	140,000	1,550,400	11·20	10,414	9,140	..	
		25,862,600	22,517,700	140,000	3,204,900	12·38	10,718	9,332	15	539 247 P.L.
1894.										
Lady-day. .	..	7,934,700	7,170,100	86,000	678,600	8·54	10,254	9,263	..	
Midsummer .	..	4,849,200	3,778,900	42,000	1,028,300	21·20	10,252	7,989	..	
	June 30	12,783,900	10,949,000	128,000	1,706,900	13·36	10,662	9,131	..	
Michaelmas .	..	5,796,000	4,907,800	52,000	836,200	14·42	10,465	8,861	..	
Christmas .	..	9,992,300	9,285,400	106,000	600,900	6·01	10,527	9,782	..	
	Dec. 31	15,788,300	14,193,200	158,000	1,437,100	9·11	10,504	9,443	..	
		28,572,200	25,142,200	286,000	3,144,000	11·00	10,574	9,305	18	762 271 P.L.

1895. Lady-day .	..	9,144,000	8,369,700	97,000	677,300	7·40	10,228	9,362	..	
Midsummer .	..	5,374,500	4,423,800	48,000	902,700	16·80	10,527	8,589	..	
	June 30	14,518,500	12,793,500	145,000	1,580,000	10·88	10,924	9,735	..	
Michaelmas .	..	6,036,000	4,977,700	111,000	947,000	15·68	11,095	9,187	..	
Christmas .	..	10,656,000	10,210,500	223,000	223,000	2·09	10,602	10,258	..	
	Dec. 31	16,692,000	15,188,200	334,000	1,170,000	6·41	10,774	9,869	..	
		31,210,500	27,981,700	479,000	2,750,000	8·81	10,840	9,719	21	{ 880 293 P.L.
1896. Lady-day. .	..	8,998,000	8,800,900	97,000	100,100	1·11	10,561	10,388	..	
Midsummer .	..	5,539,000	4,829,200	48,000	661,800	11·95	10,431	9,094	..	
	June 30	14,537,000	13,630,100	145,000	761,900	5·25	10,511	9,855	..	
Michaelmas .	..	5,994,000	5,577,700	83,000	333,300	5·55	10,608	9,872	..	
Christmas .	..	11,028,000	10,399,300	167,000	461,700	4·19	10,335	9,746	..	
	Dec. 31	17,022,000	15,977,000	250,000	795,000	4·67	10,430	9,790	..	
		31,559,000	29,607,100	395,000	1,556,900	4·93	10,467	9,820	23	{ 865 299 P.L
1897. Lady-day. .	..	10,253,000	9,565,600	200,000	487,400	4·75	10,486	9,783	..	
Midsummer .	..	6,201,000	5,636,500	100,000	464,600	7·49	11,152	10,137	..	
	June 30	16,454,000	15,202,100	300,000	952,000	5·79	10,726	9,910	..	
Michaelmas .	..	7,141,000	6,531,800	133,000	476,200	6·66	11,037	10,095	..	
Christmas .	..	12,949,000	11,387,500	267,000	1,020,500	7·87	10,701	9,411	..	
	Dec. 31	20,090,000	17,919,300	400,000	1,496,700	7·46	10,819	9,649	..	
		36,544,000	33,121,400 In store +	700,000 274,000	2,448,700	6·69 *	10,776	9,767	25	{ 910 311 P.L.

* Increase partly explained by inflation of new gasholder and laying 1½ miles of 12-inch main.

TABLE REFERRED TO IN MR. W. B. RANDALL'S PAPER ON "LOCALIZING LEAKAGES"—(*continued*).

Year and Quarter.	Half Year.	Gas Made.	Gas Sold.	Used on Works.	Leakage.		Gas Made Per Ton.	Gas Sold Per Ton.	Miles of Main.	Number of Consumers.
		Cub. Ft.	Cub. Ft.	Cub. Ft.	Cub. Ft.	Per Ct.	Cub. Ft.	Cub. Ft.		
1898.										
+In store,Dec.	31, 1897	274,000								
Lady-day. .	..	10,861,000	10,256,700	200,000	600,300	5·39	10,807	10,283	..	
			In store+	78,000						
	..	11,135,000								
+In store,Mar.	31, 1898	78,000								
Midsummer .	..	6,381,000	6,113,200	100,000	182,800	2·83	10,706	10,256	..	
		6,459,000	In store+	63,000						
	June 30	17,242,000	16,369,900	300,000	783,100	4·46	10,769	10,225	25	{ 940 312 P.L.
+In store,Dec.	31, 1897	274,000								
		17,516,000	In store +	63,000						

The method of procedure must, of course, be governed by the locality; but, as an instance, let us presume that we start from the outlet of one of the district governors, and that for 100 yards the main is laid in a straight line under a macadamized road, and has about 2 feet cover. Having ascertained the exact position of the main, a searching-rod is driven down on alternate sides of the main at each end. The space between is marked off into distances of about 3 yards each; then another rod is driven down near the side of the main, so that as nearly as possible the search-holes run diagonally, and in the trench originally excavated for the main when laid. It is hardly necessary to add that discretion must be used so that the rod does not cause damage to any water, sewer, or drain pipes, or to the gas-main itself. Having driven a rod down to about the level of the underside of the main, a little sand is placed round the top of the hole, to secure an even surface. The rod is then withdrawn, and the indicator immediately placed over the search-hole. If the pointer on the indicator remains at zero, it may safely be assumed that the main within some yards of that spot is sound. The search-hole is then filled in, the bar driven down at the next point, and so on; the testing being continued until the pointer moves and indicates a leakage. Then the value of the instrument is apparent, because you can drive down rods and note the readings until the maximum is shown, when on excavating at that spot the actual leakage will be discovered. After a very little experience, the operator becomes remarkably accurate in successfully localizing the leakage. Where the mains are laid under the footpaths, which may be paved with Victoria stone, Granolithic or York stone, the rod is driven down in the angle of the nearest joint. Tar or asphalte paving offers no such chances; but the hole made by the rod is only ⅜ inch diameter, so that it is quite easily and immediately repaired to avoid any possible complaint.

The instrument is extremely sensitive; and the pointer will indicate very minute leakages. As an evidence of this, I may mention that in some cases when the leakage was exposed it was so small that it would not burn continuously; and in other instances, when the conditions admitted, a light was applied on drawing out the bar, and it would not show the small blue flame so often found in main and service leakages. [Some of the curiosities unearthed through the use of the indicator were submitted for inspection, as well as one of the search-rods and an indicator.]

It is very remarkable how some soils have the power of deodorizing the gas, so that in the case of broken mains in frequented places no idea of their condition was entertained until discovered through using the indicator. Also in some instances leakage had occurred to the mains and services through persons having seriously damaged them, and, instead of notifying the fact to the Gas Company, had driven in rough wooden plugs, and bound up other places with sacking and white lead and various other subterfuges, to cover up the damage. One of these cases was caused by an irresponsible agent which is among the curiosities—viz., a root of ivy. This had run under a 2-inch cast-iron main, moulding itself as it grew to the shape of the pipe, and when it gained sufficient strength causing a fracture in the main. But as punishment should always "fit the crime," the escaping gas retaliated and killed the ivy.

The question will naturally arise as to whether the saving effected justifies the outlay incurred; and it may be taken for granted that where the unaccounted-for gas equals about 8 per cent., the expenditure on some such system is well warranted. The actual cost of (say) two of the indicators and six searching-rods will not exceed £4; and if the exact position of the mains is known, the actual time in testing is reduced to a minimum, as compared with any plan of metering the leakage and stripping the mains.

Many remarkable instances of difficulties caused through the elusive nature of gas leakages will have occurred to all the members; and I venture to hope that the system which I have had the pleasure to bring under your notice may save some of the trouble and expense in localizing leakages.

The figures given in the table will probably prove interesting as an instance of reduction of leakage. In submitting them, allow me to state that they are not advanced to claim the total reduction being caused directly through the leakage indicators, because we have relaid some mains and services. Neither do I wish to make any claim to have originated this particular system, or to have reached the irreducible minimum as regards leakage. But if I have succeeded in laying before you a method which may prove of some service to the members, and help the gas industry to strengthen a weak point, I shall feel well repaid for the time given to the writing of this paper.

Discussion.

Mr. J. L. Chapman (Harrow) said that, having been connected with Mr. Randall for some years, he should like to make a few remarks to open the discussion. With reference to the general question of unaccounted-for gas, he was sorry to say that at Harrow they had been progressing backwards—they had gone from a very small leakage to a large one. The only way he could account for this was that he had had a new district added on to his old one. During the time Mr. Randall was with him, they had a leakage of 4 per cent. year after year; but this had increased considerably. As to the instrument with which Mr. Randall had been testing at Waltham Cross, he (Mr. Chapman) had tried one that Messrs. Aird lent him. He used the instrument for testing the mains; but found that, after a time, it was not so effective as when he first applied it. Mr. Randall was a very clever mechanic; and it was possible he had improved upon that one, or had constructed an entirely new one. But his (Mr. Chapman's) experience was that after a time the instrument was not so sensitive as it was at first—the diaphragm seemed to become affected in some way, and the gas did not appear to have the same power upon it to show leakage that it had when he first used it. Mr. Randall had evidently given a great deal of attention to the instrument, and had thoroughly tested its value. He (Mr. Chapman) did not know whether other members in the suburban districts round London had found, as he had done, that the leakage in their localities had tended to increase of late. In his own case, he had no less than sixteen Rural District Councils to deal with, where before they had only one Council, who, with a great district, did not go to the expense of maintaining the roads in the country places. But now steam-rollers were being used everywhere; and this was one reason why the leakage was greatly on the increase in these small localities. He could not see why, in a district like Harrow, although it ran about 10 miles from east to west and from north to south, the leakage should have increased as it had done in the last four years since the passing of the Local Government Act which brought into existence these District and Parish Councils. In the Malvern Link arbitration, Mr. Alfred Colson stated that he should advise the taking up of all the mains, and laying them at a lower level. It seemed to him (Mr. Chapman) that, where they had mains only 2 feet below the surface, they should certainly now put them at least 2 ft. 3 in. or 2 ft. 6 in., to prevent injury by steam-rollers.

Mr. S. W. Durkin (Southampton) said he had had some rather extraordinary experiences with leakages in his district at different times; for the town had been in a state of chaos, owing to new sewerage works, and the laying of telephone wires and electric light culverts and ducts. While this work was being carried out, the men came across gas-mains and service-pipes pretty freely. It was all very well while the dry weather lasted; but he expected, and was not disappointed, that, when there had been heavy rain, they would find out some of their difficulties. From Oct. 28 up to Nov. 5, they had broken mains reported every day. This had caused a great deal of trouble. He did not know the instrument Mr. Randall had been employing; but he (Mr. Durkin) had been using a gas indicator about 3 inches in diameter, and had found it uncommonly useful. Especially was this so in one case, where a leakage of gas found its way into the electric light conduits, and travelled on until it got into the electric light works. The street in question was very complicated as far as the gas connections were concerned. They found a broken main under the tramway; and also a leakage on the main close to the trench opened by the electric light people. There they stopped two leakages; but still the smell of gas continued in the electric light works. Therefore they went further afield. There was a main on both sides of the street. They tested one side first; and, detecting gas, they opened the ground; but they could not find any trace of it whatever. After completing the one side, they examined the other. One of the inspectors went along the line of the electric light conduits with a detector; and at different points he found gas in the chambers. They followed up the clue, isolated the main, and put on a test-meter to try and localize it as closely as possible. At last they found a service pipe that had been tapped into the side of the main. A short time before, the steam-roller had been at work there; and, the ground being of a spongy nature underneath the pipe, the roller had drawn the pipe out of the main. So this "Will-o'-the-wisp" was at last unearthed by the detector and test-meter. At Southampton, they had frequently used these indicators and found them of great service, even without the searching-rod which Mr. Randall drove down by the mains. Leakages were constantly occurring in streets disturbed by public authorities; and gas managers had to deal with them in the safest possible way. His experience was that detectors were invaluable.

Mr. W. B. MIMMACK (St. Mary Cray) wished to accord his tribute of praise to this instrument, which he had been using for a considerable time. The necessity for something of the kind in his case would be seen when he mentioned that they had about 32 miles of main with a consumption of no more than 60 million cubic feet of gas. It would be understood that they had a large area and a great length of main; and consequently leakage was a very important point with them. It had been at a very high figure, which he should hardly like to mention there. He made several attempts to get hold of an apparatus that would give the percentage of leakage rapidly and easily. He had brought to his notice a thermometer in which there were two bulbs and stems. One of the bulbs was surrounded by a chemical compound which was stated to be a secret of the inventor. Coal gas would raise the temperature of this compound, and cause the thermometer to go up rapidly; while the other bulb was only acted on by atmospheric temperature, and remained stationary. But there seemed to be some peculiar characteristic about the chemical compound; and at times it did not appear to act with anything like the celerity that it did on other occasions. Then this apparatus, working on the law of the diffusion of gases was brought under his notice; and he tried it at once. But on one occasion when an inspector was using it, some of the local authorities peered over his shoulder, and, finding out what it was, became possessed of one. Now they went about the district lifting the manhole lids; and, if a little gas had collected in the sewers, and showed itself on their indicator, they would run down to the gas-works, and say there was an explosive mixture in the sewers, and the matter must be attended to at once. Consequently, they had found out that the instrument, although it had been a blessing to them, had been the cause of a great deal of trouble. By driving down the bar, they could arrive at the percentage of leakage, and whether they were near the seat of it. The nature of the soil into which the bar was driven made a very important difference. Some soils were highly porous; and if there was a leakage in the main, it would percolate through the soil very rapidly. On the other hand, if the main was in a clay soil, there might be a considerable leakage, and the detector would not show much of it; and it would be necessary to get almost on the spot to find it out. With regard to traction-engines, matters seemed to be getting worse and worse. In his town they had now a 15-ton roller; and Kent, he thought he was right in saying, was the only county in England where traction-engines were allowed to run riot without having to pay for a licence or something of the kind. One morning he stood at the corner of a country lane while a procession of 22 traction-engines went by. After this long procession had passed, to his astonishment he saw a 2-inch gas-main "standing out" of the ground. The side of the road was literally forced out; and the main, in more places than one, stood out about 3, 4, or 5 inches. He was surprised to find the leakage was so small as it turned out to be; but the matter had to be attended to at once. He could not help thinking that it was a pity more severe restrictions were not imposed upon these traction-engines; so that they should not be allowed to run down streets one after the other in any number. As to the 15-ton roller, in nearly every instance where roads had been newly made up, and this heavy roller had been put upon them, they had to attend to serious leakages. Particularly in suburban districts, this matter of localizing leakages was an important one.

Mr. C. E. Botley (Hastings) said he had had some experience with these instruments, and they had been extremely useful in determining the presence of coal gas. He had not, however, found that they always indicated the exact locality of a leakage in some grounds. He had had instances of a strong indication of gas; and the leakage had been at least ¾ mile away. Where this happened, the leakage was most difficult to localize. The instrument had been useful in a case where a man said he had gas leaking into his cellar. They took one of the instruments there, and found there was no leakage of gas, but a sewage smell. By the aid of the instrument, they convinced the person complaining that it was not gas; and it was afterwards found that it was a drain which was defective. The instrument had also been found useful in large towns where there was wood or asphalte paving. In one case it was decided that The Gaslight and Coke Company were liable for a leakage of gas which was occasioned by some operations—not their own—on an asphalte road, because this instrument was in existence, and would have informed them of the leakage. He certainly quite agreed that the instrument was a valuable one.

Mr. F. G. Cockey (Newport, Isle of Wight) regarded this system of testing as a very satisfactory one, especially for long lengths of main. Starting from one end of a main, and going to the other, very often an indication of a leakage was obtained; and if the main was followed up with the rod and indicator, as Mr. Randall suggested, the strongest point was almost bound to be discovered. Often indications would be obtained at the top of a hole, but the leakage would be found half-way down.

Mr. D. Irving (Bristol) remarked that the instrument was well and generally known; but he was sure they were all obliged to Mr. Randall for the example he had brought before the members, which showed what could be done with the indicator, *plus* painstaking energy and application. Mr. Randall had succeeded with this instrument; and his energy in reducing the leakage from 16½ down to 4½ per cent. was a splendid example of what could be done. He had great pleasure in congratulating him; and what he had accomplished at Waltham Cross could be done elsewhere.

The President observed that Mr. Randall's paper was one well worthy of attention; and the criticisms upon it were, on the whole, very favourable to the author.

Mr. Randall, in reply, said, in answer to Mr. Chapman, that he certainly experienced some difficulty in starting the instrument. It was very sensitive at first; but after a little use, it gradually deteriorated. He went to the trouble of taking it to pieces to find out why this happened. There was simply one tap on the instrument to allow the mixture of gas and air to escape; and he came to the conclusion that, if they had two taps instead of one, they could have a free current of ordinary atmospheric air to clear the instrument, and start *de novo*. Since then they had had no difficulty whatever—they had had no trouble regarding the sensitiveness of the instrument. What he had been able to accomplish was due to the fact that they had systematically gone over the entire district to discover leakages. Several of the defective pipes which were found were quite eaten away; and the members might well wonder why it was they were not reported before. Some of them were in places where perhaps 2000 or 3000 people passed every day. There must have been a large quantity of gas escaping, but it was never noticed. By this instrument, they were able to "spot" the exact position of the leakage, whatever the nature of the soil. Even if they were dealing with ashes (than which he did not think there could be anything more porous), and could get a hole down and were able to keep it open, by putting the indicator on the top they would most certainly come across the actual leakage, as it would be sure to pass up the hole. It would travel up that sooner than along the bed of the main. After detecting the leakage they seldom had to open more than a yard or two of main. This showed that, where they had to deal with macadam or wood paving, costing 25s. per yard, the outlay on the instrument would soon be returned—frequently in less than a week.

VOTES OF THANKS.

Mr. CHAPMAN proposed a vote of thanks to Messrs. Botley and Randall for their excellent papers.

Mr. W. A. VALON (Ramsgate), in seconding the motion, said they had to congratulate Mr. Botley upon the success which his process had achieved. But there was something more to be said upon it than had been said—there was something more to be discovered; but that would come in time. As far as Mr. Randall was concerned, he had produced a discussion which was interesting to all gas engineers. Complaints had been made with regard to the breaking of mains by steam-rollers and traction-engines. This kind of thing was no doubt very bad. But steam-rollers and traction-engines had come to stay; and therefore the only thing gas engineers could do was to put their mains down deeper, and not lay them in the slipshod way that some of the older men knew had been done in the past.

The motion was heartily agreed to.

Messrs. BOTLEY and RANDALL having returned thanks, the proceedings terminated.

The members afterwards had tea together.

MANCHESTER INSTITUTION.

QUARTERLY MEETING, NOV. 26.

This Meeting was held at Bradford, under the presidency of Mr. W. S. HADDOCK, the Engineer and Manager of the Warrington Corporation Gas-Works; and there was a fair attendance of members. On the arrival of the Manchester contingent at the Victoria Station, Bradford, conveyances started to take the party to

THE BRADFORD CORPORATION CHEMICAL WORKS.

The Frizinghall Chemical Works were established 30 years since by Messrs. Illingworth and Co., who at that time had the contract for the tar and ammoniacal liquor from the Bradford Gas Company. The works were sold in the year 1878 to Messrs. Spence and Steuart, from whom they were purchased by the Corporation in 1884; and since that date the plant has been almost entirely replaced by modern apparatus. Sulphuric acid, sulphate and muriate of ammonia, sulphate of soda, copperas, and hydrochloric acid are produced for sale; while copper sulphocyanide, prussian blue, and oxide for gas purification have been prepared in quantity from time to time, when it has been found profitable to do so.

The furnace, containing 24 ovens, is capable of burning about 35 tons of spent oxide per week. The sulphuretted hydrogen in the waste gases from the saturator is also burnt in the ovens. The Glover absorbing tower is 26 feet high by 9 feet by 7 feet, and is filled with acid-resisting blue bricks. The three chambers have, with the towers and the pipes, a total capacity of 108,500 cubic feet. The Gay-Lussac tower is 30 feet by 9 feet by 9 feet, and is filled with coke. The efficiency of the towers is good; the nitre used being less than ¾ lb. per 100 lbs. of vitriol made.

All the ammoniacal liquor is brought by gravitation in pipes from the four gas stations into a large underground storage tank. The Coffey still, measuring 30 feet by 3 feet by 3 feet, is of old pattern, and is to be replaced. The fixed ammonia is removed in a Colson still, 10 feet by 6 feet diameter. The saturator is circular, with conical bottom; and the sulphate is elevated by a Wilton discharger into a series of travelling buckets, which are emptied where required into the store. The waste liquors from the liming still are run into settling-tanks; the lime sludge being pumped on to the land, and the liquor treated with acid, and the blue recovered. The condensed water from the saturator gases (devil water) is treated by redistillation in a special Colson still. The vapours are returned to the pipe leading from the saturator; and the water runs away comparatively pure.

About 10 tons of copperas are made per week—chiefly from old tins received from the Corporation refuse destructors.

In the salt-cake furnace, 15 tons of salt are used per week; and about 25 tons of hydrochloric acid and 28 tons of purified Glauber salts are produced.

A few figures as to last year's working may be interesting 21,000 tons of liquor, of an average specific gravity of 6⅛° Twaddel, were used; 2300 tons of sulphuric acid were made; 2347 tons of sulphate of ammonia were produced, or 29·47 lbs. per ton of coal carbonized; and 450 tons of copperas were made.

Mr. Charles Wood, the Gas Engineer of the Bradford Corporation, and Mr. Wilfrid Wyld, the Manager of the Chemical Department, were present, and rendered every assistance to the members in their tour of inspection of the works, so that a very good idea was carried away of the various processes by which the residuals of all the Corporation works are treated, in order to form a better source of revenue to the department than would result from their sale to outsiders.

On returning to the town, lunch was served in the Midland Hotel; and shortly after 2.30 the members assembled for the business of the meeting. On Mr. HADDOCK taking the chair,

The HON. SECRETARY (Mr. S. S. Mellor, of Northwich) read the minutes of the last meeting, and they were approved.

ELECTION OF A NEW MEMBER.

Mr. Arthur Halliwell, of Marsden, was elected a member.

ELECTION OF PRESIDENT FOR 1899.

Mr. MELLOR proposed that Mr. R. G. Shadbolt, of Grantham, should be elected President of the Institution for the ensuing year. He had very great pleasure in nominating Mr. Shadbolt, who had been of great service to the Institution at their meetings, and had contributed many valuable papers—especially the one on purification which he read at Buxton. He was sure Mr. Shadbolt would do credit to the office of President—an office which had been filled by worthy men in the past, and he hoped would be held by equally worthy men in the future.

The PRESIDENT seconded the proposition.

The resolution was put and carried unanimously.

Mr. SHADBOLT, in returning thanks for his election, said he should endeavour, with the members' assistance, to faithfully carry out the duties of the office.

PURIFICATION.

The PRESIDENT said this subject was not being brought forward in the form of a paper, because, unfortunately, they were unable to persuade any member to write one; and at their last Committee meeting, it became a question of either abandoning the meeting, or else bringing forward the subject in the present form. He hoped this departure from the usual course would not be detrimental to the interests of the Institution. He was much obliged to Mr. Shadbolt for introducing the subject, and trusted it would lead to a really profitable discussion.

Mr. R. G. SHADBOLT said, as the President had remarked, this form of introducing the subject was somewhat of an experiment; and he would ask the members to bear with him if his efforts did not come up to the standard of the stereotyped paper. The question of purification was one which interested every gas manager, be his works large or small. It was a matter which all were from time to time called upon to deal with; and the conditions surrounding purification were perhaps more diverse than many people at a cursory glance would imagine. Strictly speaking, it might be taken that purification commenced at the moment the temperature of the gas issuing from the retort began to fall. The question of condensation, which was really the first stage in purification, was one with which they were not very greatly concerned that day; the only point about it which, to his mind, it was necessary to refer to being that the operation was one which should be confined within certain limits. If they provided no condensers, the condensation proceeded just the same; the only thing was that it went on to the detriment of those processes which followed. Condensation should be confined to its proper sphere; and it should be accomplished before the gas was subjected to any washing or scrubbing for the removal of ammonia and other impurities. Condensation might be said to consist in the removal of all that was noxious in a gas; but, incidentally, it removed many hydrocarbons, some of which would be of great value if they could only succeed in retaining them. Having, as he thought they would all agree, accepted the dictum that condensation must be cofined to its proper sphere, the next process which they came to was, both in point of order and of importance, that of scrubbing or washing. Generally speaking, it was assumed that the object of scrubbing was to remove the ammonia from the gas. This was the first object; and it could be very easily performed if they could use an unlimited supply of fresh water. Unfortunately, commercial and other considerations dictated that they should limit the supply to a very small quantity indeed. This, it had been proved, was not an altogether unmixed evil; for they found that the caustic ammonia itself had a great affinity for some of the impurities they had to remove. Scrubbing and washing, like condensation, must be confined to their proper sphere if they would have their condensation complete. The condensation was the all-important point in the cost of purification. They were very often puzzled to know why the cost of purification differed so very greatly. If they were to look into it, they would find that it was not due so much to the kind of purifying boxes they used as to the efficiency or inefficiency of the condensing and scrubbing plant. [Mr. Shadbolt referred to Statement "A," p. 394.] These figures were obtained from experimental plant, and were extreme cases; but they all went to show the point which he wished to demonstrate—viz., the varying conditions that one works might labour under compared with another in the composition of the gas in the purifiers. It might be assumed at this stage that the proper thing to aim at in purification was to bring down the proportion of impurities to something comparatively constant; and this might be done by means of the liquor itself. Experiments carried out on a large scale had been pronounced a failure; but although this process had evaded their grasp so far, no doubt some good work could be got out of liquor by means of judicious handling. The next table (Statement "B") would show what work the liquor did in this particular respect. It would be perfectly evident to all from the statement that the liquor played a very important part, and that it absorbed, when rightly applied, a great proportion of the impurities which they would otherwise have to deal with in the dry boxes. Alluding to the last analysis in Statement "B," with respect to the washer-scrubber, he said he thought this showed what clean water was capable of doing by the time it became 7° or nearly 8° Twaddel, if rightly used. The next table (Statement "C") would

STATEMENT A.

Comparative Proportions of Impurities in Gas at the Purifier Inlet from Samples of Coal and Cannel.

Sample.	Grains of Impurities per 100 Cubic Feet of Gas.		
	Sulphuretted Hydrogen.	Carbonic Acid.	Sulphur Compounds.
Cannel . .	683	2478	18·40
Coal . .	1800	1750	32·50

STATEMENT B.

Impurities Contained in Liquor (Percentage by Weight) Drawn from Various Apparatus.

Source.	Strength in Degrees Twaddel.	Percentage of Impurities.		
		Ammonia.	Carbonic Acid.	Sulphuretted Hydrogen.
Hydraulic main . .	3·0	1·55	0·28	0·11
Condenser inlet . .	6·1	3·27	6·49	1·05
Condenser outlet. .	6·0	3·22	6·52	0·94
Scrubbers (general) .	7·3	3·08	5·59	0·76
Washer-scrubber. .	7·8	2·88	7·04	0·94

STATEMENT C.

Impurities Removed by Scrubbers.

Impurities.	Scrubber Inlet.	Scrubber Outlet.	Total Removed.	Percentage Removed.
	Grains.	Grains.	Grains.	
Ammonia	3598	620	2978	82·76
Carbonic acid . . .	2100	1663	437	20·80
Sulphuretted hydrogen	785	730	55	7·00

STATEMENT D.

Cost of Purification when Carbonic Acid is Removed.

Proportion of Materials * (approximately) = 1·25 lime to 7 oxide.
[* By weight when new.]

Lime, cost per ton of coal carbonized . . . . . . 1·50d.
Labour, cost. . . . . 2·25
Loss in volume by removal of carbonic acid, 200 cubic feet at (say) 1s. per 1000 . . . . = 2·40
6·15d.
Less profit on spent material*. . . . . . = 0·55d.
„ gain in illuminating power of 1 candle at (say) ¾d. per candle × 10. . . . . = 7·50 8·05
Showing actual profit per ton of coal carbonized . 1·90d.

[* Profit on spent material includes profit on spent oxide over and above its first cost.]

STATEMENT E.

Cost of Purification when Sulphur Compounds are kept Below 20 Grs. per 100 Cubic Feet.

Proportion of Materials* (approximately) = 2·5 lime to 7 oxide.
[*By weight when new.]

Lime, cost per ton of coal carbonized		3·00d.
Labour, cost		2·75
Loss in volume of carbonic acid (as before)		2·40
		8·15d.
Less profit on spent material	= 0·45d.	
,, gain in illuminating power (as before)	= 7·50	7·95
Net actual cost per ton of coal carbonized		0·20d.

show the actual work that was being done by the scrubbers themselves. After the work performed by the scrubbers in the particular experiment to which the figures here given related, the gas would be passed through a washer where the remaining 620 grains of ammonia would be removed; but as this would affect the sulphuretted hydrogen to such a very small extent, and likewise the sulphur compounds, he thought it might be regarded as a negligible quantity. It might be taken for granted that, generally speaking, under normal conditions with mixed South Yorkshire and Midland coal, they might expect, with efficient scrubbing and washing, to find 1663 grains of carbonic acid at the inlet of the purifier, and 730 grains of sulphuretted hydrogen. Working on this basis, it was found, from actual experience, assuming that no more than two boxes were charged per week, that the area required per 1000 cubic feet per diem was 2·4 superficial feet, or 0·6 superficial foot per single box, assuming that they had four boxes to work with. The layers of purifying material would be disposed of as follows:—

Purifying Capacity Required.

Maximum number of changes	2 boxes per week.
Superficial area required per 1000 cubic feet per diem	2·4 super. feet.
Superficial area per box per 1000 cubic feet per diem	0·6 super. feet.
Number of boxes	4.

Layers of Purifying Material.

Lime	4 layers of	9 inches each,	per box.
Oxide	2 ,,	18 ,,	,, ,,

Or combined as desired with total thickness of material, 36 inches per box.

Having fixed the conditions, and decided upon the capacity of the purifiers themselves, the next and vital question which presented itself was to what extent should they purify. He would divide this subject into three heads: (1) The removal of the sulphuretted hydrogen, which, in itself, was imperative; (2) the removal of the carbonic acid; (3) the removal or the reduction of the sulphur compounds to something like the Gas Referees' requirements. The first might be disposed of very quickly. All would agree that the use of oxide of iron for the purpose of the removal of sulphuretted hydrogen alone cost nothing, when the value of the spent material was taken into account; and, in fact, in some instances, it resulted in an actual profit. Coming to the second stage—the removal of the carbonic acid—from his own experience, corroborated as well as added to by that of other people, he found that the working would be something approximating to what he had shown in Statement "D" [p. 394]. Coming to the third, or more complete stage, it would be found that the cost was a little more. (See Statement "E.") These costs were not mythical in any shape or form; they were taken from practical daily working, under conditions approximating to those previously stated. They were not all from his own experience, but were verified by the experience of both larger and smaller works, and, he thought, might be taken to be fairly representative. So far he had dealt with purification unassisted by the use of free oxygen. The point he wished to submit for discussion by the meeting was this: That, considering that what might be termed complete purification might be achieved at a cost of 0·2d. per ton of coal carbonized, taking into calculation the losses and gains on every hand, no one was justified in sending out gas partially purified. Whatever spark of argument to the contrary might be brought forward, would disappear when it was borne in mind (as he pointed out at the Buxton meeting of the Institution) that the life of the oxide itself might be prolonged threefold by the judicious use of air, moisture, and warmth; and that whatever cost there might be remaining would be entirely removed, and an actual profit result, even when complete purification was attained. Sulphur clauses or not, it was their duty to themselves, to their customers, and to everybody interested, that they should religiously purify their gas to the utmost extent, especially when it was seen that it cost practically nothing to do so.

Mr. E. E. J. ANDERSON (Ripon) asked at what point Mr. Shadbolt considered the condensation complete before passing on to the scrubber.

Mr. Shadbolt replied that he considered condensation complete when what was termed the "tar" was removed.

Mr. Anderson asked if Mr. Shadbolt considered it was complete at 60° to 70°.

Mr. Shadbolt said he attached very little importance to the temperature, but more to the state of the gas.

Mr. J. H. Brearley (Longwood) said that, knowing the subject of purification was going to be introduced, he had taken out some figures in connection with his works. During the last 22 months, they had actually made a profit from purification; but he did not want anybody to conjure up Utopian dreams of profit from purification, because during this period they were in a favourable position for selling their spent oxide. They actually made a profit of £13 18s. 10d. The quantity of spent oxide sold was 107 tons; and roughly calculating 55 tons of new to replace the 107 tons sold, this would cost, at 25s. a ton, something like £68, which would bring the outlay on purification during the period mentioned to £54 16s. 2d. The quantity of gas sold was 91,478,000 cubic feet; so that allowing for the outlay on new material, which was the first thing to estimate when seeking to arrive at the cost of purification, it was costing them ⅐d. to purify the gas. Their maximum make was about 300,000 cubic feet per day. They had four 20-feet boxes filled with oxide. Lime boxes were used as catch boxes; and the gas was passed through the oxide. The sulphur was kept within reasonable limits; and they had had no complaints either of sulphur or want of illuminating power during the last eighteen months. They also tested the lime boxes, and kept the gas free from carbonic acid. He ought to add that his results had been obtained without the admission of air. He should like to ask Mr. Shadbolt if he would give them any test he had made respecting the admission of steam and air, and as to what effect it had on the illuminating power. He could not convince himself that the admission of air did not reduce the illuminating power. He had carried out experiments, in order to test the utility or otherwise of the admission of air; and at present he was quite content to do without it. On looking through the analyses of 32 large works, he found that there were only three where the figure was below ⅐d.; and seeing that this was the case, he was quite satisfied to leave air alone.

Mr. J. Wilkinson (Drighlington) was very much obliged to Mr. Shadbolt for bringing this important subject forward, and giving them his experience. On looking into the purification accounts of various gas undertakings, he found almost every manager had a different system of making them up. According to the Parliamentary Returns, they were supposed to include in their purification charges the oil and water used on the works; but he failed to see why purification should be debited with these items. Some gas companies were far better situated for the disposal of their spent oxide than others. He had sold oxide at 4½d. per unit at the works; whereas his next door neighbour had had to be content with 2½d. He derived his advantage solely through his trade in vitriol; and it would therefore be unfair of him to compare his accounts with those of his neighbour. He noticed that Mr. Shadbolt allowed for the loss in volume of carbonic acid, but did not allow for loss in volume of the sulphur compounds. The point that struck him in Statement "B" was that 6·1° Twaddel took out 3·72 per cent. of ammonia, 6·49 per cent. of carbonic acid, and 1·05 per cent. of sulphuretted hydrogen. These were the highest figures, with the exception of one item of carbonic acid. He should like to ask Mr. Shadbolt's opinion as to really the best Twaddel for liquor. They found, in the manufacture of sulphate of ammonia, that about 5° Twaddel was the most convenient strength to work liquor; and from this he should judge that it would not be policy to work their liquor at any higher strength.

Mr. William Carr (Stalybridge) said Mr. Shadbolt did not tell them how he arrived at the figure of 7·50d. as the gain in illuminating power, which formed a very large feature in the improvement; and he should like fuller particulars with regard to this when he came to reply. The question of purification, as Mr. Shadbolt had stated, began almost as soon as the gas commenced to cool; and the scrubbers or washers played a very important part in it. Some years ago, when they used to sell their liquor, there was no doubt what was the best way to do the washing. But now that they had become sulphate manufacturers, a different complexion was put upon it. He was not quite sure that it was any special advantage to take out the sulphuretted hydrogen from the gas, and then have to remove it again from the sulphate purifiers. If they had a sulphur kiln, it would be another matter. He saw no special advantage in getting the sulphuretted hydrogen into the gas liquor, because they then had to deal with it in a way that was sometimes considerably more troublesome and obnoxious. With regard to the last speaker's query as to what strength of liquor was best calculated to remove impurities, it depended very largely on the quantity of impurities it came in contact with as to its effectiveness. The tables before the meeting could only be taken as approximate, because the quantity of impurities in the gas had to be considered, as well as the liquor used for taking them out. There could be no doubt whatever that a liquor of no strength Twaddel was really the best. What they wanted was a solution of caustic ammonia—that was free ammonia—which did not register on the Twaddel hydrometer at all. In testing it by the hydrometer, they obtained no guide as to the amount of ammonia there might be in the liquor they were using; and sometimes this was very misleading. As sulphate makers, they would be better without either carbonic acid or sulphuretted hydrogen in their liquor. They would not require to use lime in their still; and, therefore, they would obtain the ammonia from the liquor very much more readily, and probably get a nicer quality of salt. But this was by the way. On the question of purifying in closed vessels, as a sulphate maker he should like to state that the principal point of interest was getting the ammonia out of the gas. There was no advantage in getting it out by the liquor, because they had to deal with it afterwards in a less convenient form than they did in their ordinary purifiers. When they used to sell their liquor by the Twaddel hydrometer, the more impurities they could ram into it the better. He remembered some wonderful results being obtained at one works where they put up tower scrubbers. They got some fabulous results because they charged the liquor with very large quantities of impurities; and as they sold by the Twaddel test, they were paid for ammonia instead of having it deducted, because the liquor was really of less value than other liquor. As had been said, liquor of 5° strength was often the best liquor for working in the ammonia still, and gave the best results of working in proportion to its value. During the present summer, he had been using the air process in trying to work off his oxide purifiers; and a point that had struck both him and his brother was their increased troubles with naphthalene deposits. His brother drew his attention to it in the first place by saying that he found, when his apparatus had been going a very long time, towards the latter portion the naphthalene troubles increased, and he had been obliged to change his purifiers long before they were shown to be exhausted, in order to prevent the deposit of naphthalene throughout the outlying districts of the town. He found that by reducing the quantity of steam so as to get in about 1½ per cent. of air—which he had never noticed to interfere with the illuminating power in any instance—his naphthalene troubles had diminished. He mentioned this because it might be of advantage to point out to those who were using the air process the advisability of exercising great care in putting in the steam. It was shown by Mr. Shadbolt (and it accorded with his own experience) that by getting the steam and air near the purifiers, so that the steam went in to a certain extent as steam, they got a far higher duty in the way of revivification than they did by putting in the steam a long distance away, so that it was condensed before it got up to the purifiers. The moisture being in conjunction with the air seemed to give a greater effect to the action of the air in the purifiers. He had found it a very easy matter to set the oxide on fire in his sulphate purifier. This led to a little trouble; but it showed that the activity of the oxide in the air took place to a much greater extent, or with much greater energy, when it was accompanied by the warmth and moisture of the steam than it did if it were put in in a dry condition. The only difficulty in dealing with it was that they had to remember that when they let in the steam, when the oxide was nearly spent, a larger quantity went forward with the gas, and then when it got out into the street-mains, more especially in small services and places where it was exposed to changes of temperature, the steam was condensed, and in the act of condensation deposited naphthalene. There was no doubt it had some effect upon naphthalene, because it was still as elusive as ever, and they were still as far off any solution of the naphthalene question as ever. But he had no doubt, from his own experience and from what he had gathered from others, that the fact of the steam being admitted into the purifiers did affect the deposit of naphthalene in the street-mains. He was greatly obliged to Mr. Shadbolt for the way in which he had opened the discussion, which was certainly quite a new departure that was well worth following. It was not always convenient to the members of the Institution to write papers, but probably when they found they could introduce a subject in the way this had been introduced, they might feel more disposed to do it than they would if they had to set to work to write out a set paper in the usual way. Mr. Shadbolt had put before them a very important subject; and he (Mr. Carr) only regretted that he did not know a little beforehand the lines he was going to take, so that he might have prepared himself for the discussion. He hoped they would hear something more on the lime question; and he trusted that Mr. Townsend would give them a word or two on the point.

Mr. H. Townsend (Wakefield) said, as Mr. Carr had dragged him into the discussion, there was no way of getting out of it except by following on the lines indicated. In the first place, he wished to congratulate Mr. Shadbolt on the excellent way in which he had introduced the subject. He (Mr. Townsend) was rather taken by surprise, and did not expect to receive all the information he had obtained. If Mr. Shadbolt had prepared a set paper, it could hardly have contained any more. With regard to the question of purification, he (Mr. Townsend) certainly did hold some rather strong opinions. He had not the slightest doubt in his own mind that it was certainly the right thing to extract all the carbonic acid; and he was very glad to find that Mr. Shadbolt also took such a strong line, and had so unhesitating an opinion in favour of taking out the sulphur compounds as well. At Wakefield, although they were only under the ordinary provisions of the Gas-Works Clauses Act, and therefore merely limited to removing the sulphuretted hydrogen, yet, as the Corporation had appointed a chemist to analyze their gas, they found it would be expedient to remove all the sulphur compounds—so that, although they were under no obligation in this respect, they did take out all the carbonic acid and all the sulphur compounds. The reason he had so strong an opinion about the former impurity was this: As most of the members were well aware, some two or three years ago he was Engineer of the Plymouth Gas-Works. When he first went to that place, he travelled down on a winter's day. He had a very long journey; and, not having much to do, he amused himself by looking at the gas at the different stations through which he passed, and trying to settle in his own mind the method of purification adopted. This he found to be a very easy task. It was not difficult for any expert to detect when the purification was simply done with oxide of iron, and when the process was backed up by the elimination of all the carbonic acid. Purification simply by oxide of iron produced a gas that was distinctly yellow; while gas purified of carbonic acid was white. He made some notes with the object of ascertaining whether or not his impressions were correct; and, on making inquiries subsequently, he found they were. When he got into the southern part of Devonshire, he was greatly struck with the difference in the appearance of the gas from what it was in the Midlands. There it was exceptionally white. He found in town after town a gas of very low illuminating power, but very white; and he came to the conclusion that this part of Devonshire was a limestone district. Next morning, when he visited the gas-works, he was anxious to find out whether or not the deductions he had drawn were correct. Accordingly, one of the first questions he put to his predecessor was as to whether they did the purifying altogether with lime. The reply was in the affirmative. He was told that it was entirely a limestone district, and that the buildings were all of limestone. On one occasion while at Plymouth, having to visit the Midlands, he went to the Post Office of one of the large towns, and was struck by the sulphurous atmosphere caused by the gas. Of course, by purifying entirely with lime, as they did at Plymouth, the gas was exceptionally pure. He then came to the conclusion that it certainly paid to take out the sulphur compounds; and further experience had amply confirmed him in this opinion. He was quite at one with Mr. Shadbolt that, apart from the financial aspect of the question, as a commercial transaction it paid to remove all the sulphur compounds they could possibly take out, and also every particle of carbonic acid. If they wanted to take the sulphur compounds out, they must remove the carbonic acid. He also agreed that it cost very little to do; and that, taking out the carbonic acid made a difference of at least one candle in the illuminating power. Of course, he was not in a position to criticize Mr. Shadbolt's figures, as they had only just come into his hands.

Mr. G. E. STEVENSON (Manchester) did not know whether Mr. Townsend had lately visited Manchester; but if he had, he would have found the gas was a little whiter than it was in some modern towns. He was afraid Mr. Townsend was not quite right in suggesting that the absence of carbonic acid was the sole reason for the gas appearing white. He was rather inclined to think that there were various ways of making gas a pure white—some, perhaps, more costly than others. He was much indebted to Mr. Shadbolt for bringing the subject forward in the way he had. Of course, purification was a vast subject, and one that had so many side branches that any one of them would form the subject of discussion. It was better to have the question brought before them on general lines, so that they might take general views of it. They would all accept Mr. Shadbolt's proposition that the beginning of purification was the deposition of tar from the gas—in fact, purification could not take place until this had been accomplished; and then began the abstraction of further impurities. He was inclined to think, from his own experience of the last half-dozen years, that the abstraction of carbonic acid was perhaps one of the most important factors. There was no doubt in his mind that the great proportion of carbonic acid in the gas in northern towns was largely attributable to the reluctance of some gas-works' owners to launch out into the question of sulphur purification.

Where considerable amounts of cannel and of the medium coal from the Wigan and the Nottingham district were used, the proportion of carbonic acid was very rarely less than 2½ per cent. Now, this was a very difficult quantity to deal with in sulphur purification. In London and the southern towns generally, the carbonic acid did not exceed 1½ per cent.; and then, of course, it was more amenable to control. But if, with 2½ per cent. of carbonic acid in the gas, they in Manchester were to go in for sulphur purification, it would mean a very great consumption of lime. He did not say it could not, or ought not to be done; but seeing that the expenditure of lime would be great in proportion as the carbonic acid in the gas was high, he thought they ought to cast about to see if there were not some means of previously reducing the carbonic acid contained in the gas. This he saw from Mr. Shadbolt's figures could be done to a certain extent —in fact, according to those figures, it would be seen that something over 25 per cent. of the carbonic acid was taken out in the condensing and washing appliances previous to the purification. This was a good result, so far as it went. But he believed they were all acquainted with the fact that there were gentlemen in the profession who were endeavouring to do something much further than this, by washing gas with liquor which had been freed to a large extent from its carbonic acid fixed in combination with ammonia, and using the liquor over again. He really thought that many of them might with advantage devote some attention to this side of the question, and endeavour to ascertain whether it was not possible, by means of apparatus of moderate cost, to effect the abstraction of a much larger proportion of the carbonic acid—in fact, something amounting to 40 or 50 per cent., instead of 25 per cent. If they could do this, they would be in a much better position to deal with the question of purification from sulphur. Of course, it was rather difficult to discuss Mr. Shadbolt's figures or to call them in question; but he was inclined to think that the opener erred in one respect—viz., in regarding the keeping of the sulphur compounds below 20 grains as involving greater expense in lime than the purification from carbonic acid. He could not conceive why more lime should be required in purifying from sulphur compounds than in purifying from carbonic acid, if the purification from carbonic acid was complete. There was no doubt that the consumption of lime, in purifying with lime, was to be regulated by the carbonic acid in the gas. It was always in excess. It invariably had to be taken out before the sulphur compounds could be reduced; and the quantity of lime that required to be used depended entirely, in his opinion, upon the proportion of carbonic acid. Mr. Carr had made some very pertinent remarks in regard to the use of air and steam in oxide purification. To his (the speaker's) mind, the application of air was far more useful in connection with lime than with oxide. It had been found by those who used lime in sulphur purification that it was absolutely necessary to maintain the sulphur purifiers at a certain temperature, approximating to 90°. The simplest and the best way to do this was to introduce into the purifiers a certain proportion of air, which, having a chemical action in conjunction with the lime and the sulphur, maintained the temperature. The easiest method of injecting this air into the gas was by a steam-jet. In using steam, there was something to be said in favour of the oxide lasting a longer time, and doing more work. It lasted longer, perhaps, because it remained in a porous and free condition, and did not cake. There was no doubt it wanted a good deal of careful control and supervision, because one had a good deal of moisture in the gas, which tended to produce naphthalene deposits. He was convinced that the more saturated the gas was with moisture as it entered the street-mains, the more likely it was to cause naphthalene troubles. In conclusion, he expressed his appreciation of the way in which Mr. Shadbolt had come forward with the subject, putting it before the meeting in a general way so that it was open to discussion on all sides.

Mr. G. H. NIVEN (Cleckheaton), as an old friend of Mr. Shadbolt, wished to thank him for the able manner he had dealt with the question of purification. Having had some experience in the matter, he should like to ask Mr. Shadbolt for his hypothesis on the use of moisture. When Mr. Shadbolt had charge of the North Bierley works, he saw his system, which he would now call (for want of a better term) "hot purification." He introduced it at his own works with great advantage for some time, so far as the life of the oxide in the purifiers was concerned; but the advantage gained was discounted by that pest to which Mr. Carr had referred—naphthalene in the services, &c. In considering oxide purification, anyone thinking over the matter for a moment would come to the conclusion that the time at which the oxide of iron was doing most work in abstracting the sulphuretted hydrogen from the gas was when it was anhydrous. If this were so, they must look for a new hypothesis. From certain experiments he had made, and from his experience with naphthalene troubles, he had now arrived at the conclusion that the extra life obtained for the oxide of iron in the purifiers was not due altogether to the amount of moisture introduced by the steam, but to the fact that, condense as they might, certain light hydrocarbons would find their way into the purifier boxes; and, under the system of cold purification, as soon as they came in contact with the under side of the lid and the sides of the purifier, they condensed, and filled up the cells of the oxide of iron which was lying in the purifier, and in so doing robbed them of the bulk of the material lying in the boxes. The benefit that was derived from the introduction of hot purification was due to the fact that, owing to the temperature in the boxes being raised, the light hydrocarbons were sent forward, and the cells of the oxide remained open, and offered a larger surface for chemical action to the incoming gas. With the hot purification process, when they pumped the gasholder syphons, he found they had a large amount of light oils floating on the water so pumped from the syphons, and he had some trouble with naphthalene deposits in the mains. In his opinion, the members meeting together and discussing this important subject was of great benefit to all.

The President, before calling upon Mr. Shadbolt to reply, wished to thank him for the very interesting subject he had brought forward. He certainly thought the way in which the matter had been introduced would lead to great benefit being derived both by the consumers of gas and the managers of works. The profit of 0·2d. shown in Statement "E" depended very much upon the cost of the lime, and the price they could get for the spent lime. In Warrington some years ago they got 4s. a ton for it, whereas now he did not think they could get rid of it at any price, but would have to go to the expense of finding a tip for it. Lime certainly gave gas a brighter appearance. They had to use rather more cannel; but in Warrington, being near to the cheap cannels, they could buy them at practically the same price as coal. Now they only used lime on altogether exceptional occasions. In using lime, they found great difficulty in working the oxide and lime together. The boxes were so situated that they could not have one box and devote it entirely to lime, and consequently they had to clean out their boxes every time they used them; otherwise they had a great loss in the spent material. Another difficulty that they met with was in the traces of sulphuretted hydrogen that they found. He had had a return showing the quantity of sulphuretted hydrogen leaving the purifiers. The purifiers were put in a row 47 feet by 20 feet. The first purifier took out practically all of the sulphuretted hydrogen. The quantity of sulphur passing the first purifier was about 100 grains per 100 cubic feet. In the second purifier it was reduced to 50 grains. The next contained only a trace of sulphuretted hydrogen; and so on from one purifier to another. The lime would take out the traces of sulphuretted hydrogen much more readily than the oxide would. They had tried one little experiment at Warrington with the introduction of air by the steam-jet, with a very melancholy result. They started at noon and put in 1 per cent. of air for six hours; and next morning he was informed that the whole of the street-lamps were blocked. If they used steam, it was very necessary that they should start with their oxide fresh; for if they started with old oxide, it had a tendency to drive the naphthalene forward.

Mr. SHADBOLT, in reply, said that when he brought forward the subject he was rather doubtful of raising any discussion; but he was happy to say this doubt had been dispelled. Mr. Brearley stated that his purification cost him $\frac{1}{7}$d., and that he removed carbonic acid. Statements "D" and "E" showed the benefit to be derived from removing this impurity. Mr. Brearley did not show a profit because he did not credit himself with any gain in illuminating power. There was a decided gain in this respect by removing 2 per cent. of the carbonic acid. In reply to Mr. Brearley's question as to the effect on the illuminating power produced by using steam and air, he would refer to the paper he read at the Buxton meeting, towards the end of which would be found a short statement giving the effect of introducing various proportions of air. If his memory was correct, anything up to 1½ per cent. had no deteriorating effect. In reply to Mr. Wilkinson, as to the loss of the sulphur compounds, he had treated this almost as a negligible quantity with regard to the effect upon the volume of the gas. Perhaps some of them would wonder why he had omitted giving sulphur compounds in his analyses; but this was because he did not get them. As to the strength to which the liquor should be worked, as a sulphate maker he should prefer to have his liquor not above 5° Twaddel. His aim was to show what could be done with the liquor in the way of removing impurities; but as to the effect in sulphate making, perhaps Mr. Wilkinson would let them know something later on. It would ill become him to attempt to deal with Mr. Carr's remarks, which were very exhaustive. With regard to the illuminating power gained for the gas by the removal of the carbonic acid, he could merely say, in corroboration of what he had stated, that the water-gas makers said that there was a distinct loss experienced by leaving in the carbonic acid, but that they could enrich so cheaply that they did not trouble to take it out. With respect to the naphthalene troubles, he was sorry to say that naphthalene could be largely increased by the adoption of the air and steam process. He had discovered this after using it for some considerable time; but the difficulty was not insurmountable. It was a question of regulating the moisture. When using oxide boxes, if a thin layer of lime were placed at the bottom, and care taken to condense out the greater proportion of the steam before it entered the purifier, he thought the moisture could be kept within such bounds as to have no detrimental effect with regard to naphthalene. He was much obliged for Mr. Townsend's remarks, which corroborated his own. He could not quite agree with Mr. Stevenson, though he felt he must bow to his more extended experience; but, so far as his observations and those of his friends went, he was certainly correct when he said that it took more time to remove the sulphur compounds under the conditions he stated than it did to remove the carbonic acid. He was sorry to hear that he had brought Mr. Niven into such trouble. He seemed to have got a lot of people into trouble with the steam process. He took it that the action in question was this—that the use of the moisture was not so much to assist the oxide (as such) to do its work, as to re-oxidize the spent material. He did not think the effect of the use of moisture was an hypothesis; it was a demonstrable fact. He thanked the President for adding to his statement, and commiserated him upon his melancholy experience. He remembered one gentleman who lived in the neighbourhood, and was a chemist of the first order, who adopted the process only to drop it like a hot potato, for the simple reason that he saturated his gas to such an extent with steam that his oxide was literally mud. Of course, in such a case as that, the result would be most melancholy indeed ; but there was a happy mean which should be adopted. He could not give the exact humidity required; but there was no doubt, when the happy mean was once found, the effect would be beneficial all round.

The Late Robert Hunter.

The **President** said before proceeding with the next business on the *agenda*, he had a melancholy duty to perform, and one that he would have brought forward earlier in the day but for the fact that he had waited till there was a full meeting. He wished to propose the following resolution : "That the Manchester District Institution of Gas Engineers tenders a vote of condolence to the widow of the late Robert Hunter."

Mr. R. **Porter** (Elland) seconded the resolution. He said he had been intimately acquainted with Mr. Hunter for many years; and he was quite sure the members of the Institution had the sincerest sympathy for his widow and children. The members were already showing their sympathy in a practical way; and if there were any present who, from any cause whatever, had refrained from sending a subscription to the fund being raised for this purpose, he hoped they would reconsider any decision they had come to, and look upon it as a duty to help Mrs. Hunter and her young children. He knew what it was to have to battle with life; and when he heard of the death of Mr. Hunter, and knew that his family were not well provided for, he felt it was his duty and the duty of every member of the Institution to do something for the fatherless and the widow.

The vote was carried unanimously.

The **Secretary** wished to call the members' attention to the present state of the fund which had been raised in response to the circular he had sent out. Their fund was confined to members of the Institution, and up to that morning the amount promised was £112 10s. 6d. Included in this amount there were ten subscriptions of 5 guineas, and one of £5. There were only 51 subscriptions in all, out of a total number of members of something like 130 to 140, which to his mind was not enough. There had also been a fund raised by the *Journal of Gas Lighting* from friends of the late Mr. Hunter;* and this fund would be disposed of in a somewhat similar manner to the one they were themselves raising.

Mr. J. H. **Brearley** (Longwood) then read the following paper—

THE BALANCE-SHEET.

The subject I am introducing to you for discussion to-day is a far-reaching and important one; and when the treatment of certain items in the preparation of the balance-sheet may produce serious difference in the purchase value of a statutory company, careful consideration is called for. The method of treatment, too, of various items of expenditure, produces a material influence upon comparative analyses; and an absence of uniform methods renders the latter more or less unreliable. But more will be said about this later. I will not unduly take up the time of the meeting with generalization, but will proceed to introduce a few points that provide interesting matter for reflection and debate. I wish to acknowlege here my indebtedness to those members who kindly sent me a copy of their last annual accounts.

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* The total amount of the *Journal* fund was about £300.

In opening the balance-sheet of a statutory company, one usually finds the "Statement of Share and Loan Capital" at the head. Generally speaking, these accounts afford a rough idea of the stability or otherwise of the financial side of the undertaking when compared with the amount of gas sold. But this, in many cases, may be more apparent that real. The following comparative table of nine Yorkshire Companies of similar size gives an effective illustration of this. The figures are taken from the Board of Trade returns for gas companies for 1896. In one or two of the cases given, the obtaining of statutory powers was attended with keen opposition. Lawyers, parliamentary agents, and experts had a harvest-home. The capital accounts of the poor companies became considerably larger, under the heading of "Costs of Promoting Special Act;" and either shareholders or consumers have had to "pay the piper" ever since.

No.	Annual Sale.	Capital Paid Up.	Average per Million Cubic Feet.	Dividend on Ordinary Stock.
	Cubic Feet.			Per Cent.
1	39,234,000	£40,920	£1043	5
2	50,854,000	24,500	481	12
3	48,833,800	39,500	808	10
4	46,127,000	44,270	959	7
5	40,607,000	24,877	612	11
6	41,099,700	25,000	608	10
7	41,577,900	43,304	1041	8½
8	51,000,000	18,666	366	9
9	34,996,800	25,500	728	10
Totals . .	394,330,200	£286,537	..	..
Average of works.	43,814,466	£31,837	£727	..

But this is an abstruse matter. Something else is needed to explain why the ratio of capital per million of works of similar size in the same county should vary from £366 to £1043. The most plausible explanation seems to be that the undertakings with the smallest ratio have been working too near the borderline of disaster, and have neglected to keep the works well abreast of the requirements of the district. On the other hand, when the proportion of capital per million sold gets into four figures, it seems to indicate a lavish and injudicious expenditure at some period in the history of the undertaking. In very small works, especially if an Act has been applied for, the four-figure ratio may have been unavoidable; but in any case of this kind, whether in large or small works, it ought to be the special aim of those responsible to foster the consumption by all possible means, without unduly adding to the burden of capital. Among the accounts of companies which I received, the ratio of capital per million sold was found to extend from £351 to £1364.

In circularizing the members for a copy of their last accounts, it was my intention to get out some figures respecting the actual amount of unredeemed capital on corporate undertakings; but I had reckoned without my host—the balance-sheet. The producers of some of these interesting documents seem to have got the impression that simplicity is not by any means the acme of perfection; and the way in which the sinking funds, annuities, and loans get inextricably mixed up with other matters, is enough to drive a man crazy, even though he may fancy himself a bit of an accountant. On the other hand, there are corporate accounts that it is a real pleasure to peruse—one has but to read to understand; and were it not that I had pledged myself not to mention the names of undertakings, I should feel impelled to give special commendation to the lucid accounts issued by a few corporations, and copies of which I have been fortunate enough to secure. In despair, I turned to the Parliamentary Returns; and though their publication is something akin to ancient history, they proved to be of some value, and helped to extricate me from the fog into which I had unwittingly plunged myself.

For 1896, the returns give the amount of capital paid up and gas sold by Companies to be as follows:—

Share and premium capital	£41,433,325
Loans issued	8,185,700
Total	£49,619,025
Gas sold	73,750,533,649 c. ft.

Ratio of capital per million cubic feet sold, £673

The returns for Local Authorities for the same year are—

Amount of loans and capitalized value of annuities authorized	£29,984,828
Less amount of the loans repaid, annuities redeemed, and amount placed to sinking fund.	6,057,445
Net capital	£23,927,383
Gas sold.	43,132,780,085 c. ft.

Ratio of capital per million cubic feet sold, £555

This gives a difference in favour of corporations of £118 per million. The companies, too, have a greater percentage of interest or dividend to raise upon the larger ratio of capital.

The question of municipal *versus* company control of gas-works was ably dealt with at Bath last year;* but there is one point to which an allusion may be made here—that is, that the amount required for sinking fund and repayment of annuities cannot be set off as a permanent disadvantage to the corporate consumer, for he is gradually reducing the capital ratio, and if he lives long enough will obtain his reward in cheaper gas. But this is subject to just one condition; and the whole question hinges upon it. As Mr. Isaac Carr has so ably shown us, he ought not to be called upon to practically make a free gift to the local authority of the control of the gas supply, and be fleeced on behalf of the rates in addition. Then municipalization becomes a disadvantage. At this point, one instance comes to my mind of a large corporation heavily burdened with capital, with a big price for gas, quite recently appropriating a large sum in aid of the rates. Yet all the while the large expenditure on capital account hangs like a millstone round the neck of the gas undertaking. Is there any wonder that, under such circumstances, electric light is rapidly developing? Another corporation claim credit for having placed a sum of nearly £1500 for new mains, services, and meters to revenue, which really should have been placed to capital; while in the same year the consumers were taxed to the extent of 2·63d. per 1000 cubic feet for the sinking fund, and 1·77d. for the borough fund. The consumer would probably not have objected to being excused payment of the last item. This is but typical of most corporate undertakings.

In these days, when so much is being said and published about cheap gas, it is well to bear in mind the anomalous position which statutory companies hold as compared with local authorities, in respect to the capital employed. Parliamentary obligations render it practically impossible for even over-capitalized companies to effect a reduction of capital, since profits must not be utilized for this purpose. A substantial increase in the sale of gas may improve the proportionate ratio; but interest and dividend must be provided year after year on a never reducing, but almost invariably increasing, capital account. Local authorities, on the other hand, are compelled to repay their loans and redeem their annuities in a given term of years; and year by year the ratio of interest decreases. In this way, those local authorities who were fortunate enough to secure the gas undertakings a good many years ago, are now reaping the reward of the reduction of the capital expenditure; but, generally speaking, the first few years following the acquirement of a gas undertaking press more hardly upon the consumer than if the concern had not changed hands.

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* See *Journal of Gas Lighting*, Vol. LXX., pp. 92, 94.

It has been stated that the rate of interest on loans which companies are called upon to pay, as compared with corporations, is about 15s. per cent. more. As bearing upon this matter, it may be said that out of 26 companies effecting loans, 11 have been able to secure all or part of their loans on promissory note or mortgage at 3 per cent. The rate of interest on all loans varied from 3 to 4½ per cent.; and unless the companies paying the latter rate have bound themselves to retain the loan for a long term of years, there seems to be little reason why they should continue to pay 50 per cent. more interest than others. Another very remarkable instance was supplied in the fact that a large corporation pay 3½ per cent. on over £70,000, while a neighbouring gas company have managed to secure a loan of £10,000 at 3 per cent. About twelve months ago, a Yorkshire company endeavoured to reduce the rate of interest paid on loans. An advertisement was inserted in several Yorkshire papers offering 3½ per cent. for loans on promissory note; but only one application of £500 was received.

Now as to the capital and revenue accounts. Under the prescribed form of accounts, provision is made in the capital accounts for new meters (not in place of old ones), including fixing. It seems to be quite a common thing for local authorities to debit the cost of all new meters to revenue—a practice that will ultimately hurt the consumers less than the appropriation of profits. One corporation, for example, finished the year with a loss of £118; and a foot-note in the statement of accounts explains that this unhappy result was brought about by placing items to the revenue account which ought to have been placed to capital. But several companies do the same thing, even paying for prepayment meters out of revenue. The rush for prepayment meters proved too much for some companies paying for meters out of revenue; and they struck a middle course—prepayment meters being debited against capital, and ordinary meters against revenue. I am speaking, of course, purely of meters for new consumers. Debiting revenue with all meter charges undoubtedly conduces to the stability of an undertaking; and, if over-capitalized, it may be a very shrewd policy to adopt. But where the shadow of being purchased by a local authority hangs over the concern, then it effects a reduction of net income or profit, upon which the purchasing value is usually estimated. If a company (say) debits revenue with £200 per annum for meters that could legitimately be placed to capital, the loss in purchase value, at 28 years' purchase, would be £5600. This holds good with any other item put to revenue that could be properly debited to capital. But there is another phase to the question. Any undertaking whose Special Act incorporates with it the Gas-Works Clauses Act of 1871, is, according to clause 35 of the latter, liable to a penalty of not less than £2 per day so long as the accounts are not made out in compliance with the particulars specified in Schedule B annexed to that Act. This schedule clearly interprets that new meters not in place of old ones should be charged to capital.

The practice of paying for items of capital expenditure out of revenue cannot be said to injure a company who continually realize an amount sufficient to pay maximum dividends. It is the consumer who then suffers. One company paying maximum dividends actually charge all the cost of new meters (including prepayment ones) to revenue, and a large proportion of the cost of new stoves which are let out on hire, in addition. This is undoubtedly an injustice to the consumer. As no stocks of fittings or stoves are kept, it is easy to imagine, too, how this company can cut its coat to suit its cloth. If a good year has been experienced, a large stock of stoves may be laid in (say) in December, and thus keep the revenue profits within manageable limits. If adversity strikes the company in any succeeding year, the stock can be reduced to the advantage of current expenditure; and as new stoves will not weigh so heavily on the debit side of revenue, the profits will still be good. Meters can be manipulated in the same way. Of course, I do not for a moment suggest that the responsible persons of this company are guilty of these tactics; but they have proved themselves remarkable tacticians when burdened with too much surplus. As ratepayers, the consumers may some day get their own, or a portion of it, if the mantle of purchase should happen to settle in that district.

In some balance-sheets, receipts for spent lime or oxide are placed on the credit side of the revenue account. It would be better to deduct receipts of this kind from the outlay on purification, as, indeed, is already done in most cases. The net cost of the latter is then obtainable at a glance. When comparing analyses of the cost of purification in small or medium-sized works, an average should be taken over four or five years, as it frequently happens that a purchase of oxide will suffice for two or three years. If in a given year no oxide is bought, and at the same time a consignment of spent material is sent away, the cost of purification will be much below its normal average.

In all instances, comparisons of the cost of repairs and maintenance of works, mains, and meters should extend over a number of years. Published analyses should form a good index of what a fair average expenditure is. Yet, in a recent arbitration case, there seemed to be a difference of opinion, even among experts, as to whether 4d., 5d., or 6d. per 1000 cubic feet was a fair expenditure on maintenance of works. Some companies and corporations, too, prefer to swell the expenditure under "Repairs" with items that could legitimately be placed to capital account under the head of "New Works;" while under some circumstances there is a temptation to adopt the opposite and less excusable policy. Of the balance-sheets which have been sent in, the average rate per 1000 feet sold (not including gas used on works) at which maintenance of the works was carried out during the past twelve months has been taken, and tabulated under Tables A to G. The rate of 30 companies was found to vary from 1·42d. to 6·73d.; while the average over all was 3·14d. A digest of the accounts of 25 local authorities showed the average rate to be 3·24d.; the rates varying from 1·13d. to 8·02d. Figures covering no less than 55 works must be taken as fairly representative, since works having a

TABLE A.—*Statutory Companies Selling Less than 30 Million Cubic Feet per Annum.*

No.	Gas Sold.	Amount Spent on Repairs and Maintenance of Works.	Rate per 1000 Cubic Feet of Gas Sold.
	Cubic Feet.	£ s. d.	d.
1	8,213,000	121 18 10	3·56
2	12,847,000	246 8 0	4·60
3	19,709,300	260 14 1	3·17
4	16,500,000	297 16 3	4·33
5	10,200,000	136 2 1	3·20
6	29,497,500	455 15 0	3·71
7	27,696,500	228 18 4	1·98
8	25,458,000	214 2 10	2·02
9	13,829,500	204 15 6	3·55
10	3,500,000	21 7 5	1·46
11	17,112,200	234 15 6	3·29
Totals .	184,563,000	2,422 13 10	..
Average of works	16,778,455	220 4 10	3·15

TABLE B.—*Statutory Companies Selling between* 30 *and* 100 *Millions.*

No.	Gas Sold.	Amount Spent on Repairs and Maintenance of Works.	Rate per 1000 Cubic Feet of Gas Sold.
	Cubic Feet.	£ s. d.	d.
1	52,661,000	1,407 9 9	6·41
2	43,752,000	751 1 7	4·12
3	71,688,400	1,205 5 8	4·03
4	85,744,800	1,101 9 6	3·08
5	42,091,900	1,185 12 11	6·73
6	46,300,000	1,199 19 11	6·22
7	50,398,700	990 16 9	4·72
8	98,869,000	1,362 3 7	3·30
9	46,122,700	423 16 0	2·20
10	32,678,000	420 13 1	3·09
11	63,185,200	1,286 2 2	4·88
12	53,208,000	1,255 13 0	5·66
13	36,300,000	253 15 10	1·67
14	70,000,000	913 3 1	3·13
15	63,500,000	381 15 3	1·42
Totals .	856,497,700	14,138 18 1	..
Average of works	57,099,847	942 11 10	3·96

TABLE C.—*Statutory Companies Selling over* 100 *Millions.*

No.	Gas Sold.	Amount Spent on Repairs and Maintenance of Works.	Rate per 1000 Cubic Feet of Gas Sold.
	Cubic Feet.	£ s. d.	d.
1	102,601,000	1,002 16 4	2·34
2	320,000,000	2,440 8 2	1·83
3	112,892,000	1,524 5 3	3·24
4	214,313,000	1,897 17 5	2·12
Totals.	749,806,000	6,865 7 2	..
Average of works	187,451,500	1,716 6 9	2·19

SUMMARY.

No. of Companies.	Sale per Annum.	Total Annual Sale.	Amount Spent on Repairs and Maintenance of Works.	Rate per 1000 Cubic Feet of Gas Sold.
	Millions.	Cubic Feet.	£ s. d.	d.
11 (Table A)	Under 30 . . .	184,563,000	2,422 13 10	3·15
15 (Table B)	Between 30 & 100	856,497,700	14,138 18 1	3·96
4 (Table C)	Over 100 . . .	749,806,000	6,865 7 2	2·98
30 Totals .	..	1,790,866,700	23,426 19 1	..

Average rate of repairs and maintenance of works of 30 companies of all sizes, per 1000 cubic feet of gas sold, 3·14d.

TABLE D.—*Local Authorities Selling Less than 30 Million Cubic Feet per Annum.*

No.	Gas Sold.	Amount Spent on Repairs and Maintenance of Works.	Rate per 1000 Cubic Feet of Gas Sold.
	Cubic Feet.	£ s. d.	d.
1	25,118,000	386 1 4	3·68
2	13,152,000	439 15 8	8·02
Totals.	38,270,000	825 17 0	..
Average of works	19,135,000	412 18 6	5·17

TABLE E.—*Local Authorities Selling between 30 and 100 Million Cubic Feet per Annum.*

No.	Gas Sold.	Amount Spent on Repairs and Maintenance of Works.	Rate per 1000 Cubic Feet of Gas Sold.
	Cubic Feet.	£ s. d.	d.
1	72,778,000	382 5 10	1·26
2	99,597,000	1,683 7 0	4·05
3	52,260,000	790 8 5	3·63
4	67,211,000	656 16 9	2·34
5	30,749,000	504 7 4	3·93
Totals.	322,595,000	4,017 5 4	..
Average of works	64,519,000	803 9 1	2·98

TABLE F.—*Local Authorities Selling between 100 and 200 Million Cubic Feet per Annum.*

No.	Gas Sold.	Amount Spent on Repairs and Maintenance of Works.	Rate per 1000 Cubic Feet of Gas Sold.
	Cubic Feet.	£ s. d.	d.
1	128,626,300	3,233 0 8	6·03
2	146,065,000	896 13 5	1·47
3	103,604,000	1,235 13 10	2·86
4	139,861,000	1,481 12 4	2·54
5	157,916,000	1,762 8 2	2·67
6	130,000,000	3,036 5 11	5·60
7	114,929,700	1,115 3 9	2·32
8	105,511,000	1,627 8 3	3·70
9	137,312,600	649 18 11	1·13
10	176,213,000	1,277 6 7	1·75
Totals.	1,340,038,600	16,305 11 10	..
Average of works	134,003,860	1,630 11 2	2·92

TABLE G.—*Local Authorities Selling over 200 Million Cubic Feet per Annum.*

No.	Gas Sold.	Amount Spent on Repairs and Maintenance of Works.	Rate per 1000 Cubic Feet of Gas Sold.
	Cubic Feet.	£ s. d.	d.
1	309,354,400	1,564 13 2	1·21
2	358,914,000	6,268 16 6	4·19
3	256,932,000	1,670 7 3	1·56
4	527,553,000	4,509 3 0	2·05
5	1,588,000,000	28,261 10 11	4·27
6	1,036,009,000	9,030 17 4	2·08
7	519,780,000	7,817 0 9	3·60
8	260,000,000	8,268 1 6	7·63
Totals .	4,856,542,400	67,390 10 5	..
Average of works .	607,067,800	8,423 16 4	3·33

SUMMARY.

No. of Local Authorities.	Sale per Annum.	Total Annual Sale.	Amount Spent on Repairs and Maintenance of Works.	Rate per 1000 Cubic Feet of Gas Sold.
	Millions.	Cubic Feet.	£ s. d.	d.
2 (Table D	Under 30 . . .	38,270,000	825 17 0	5·17
5 (Table E)	Between 30 & 100	322,595,000	4,017 5 4	2·98
10 (Table F)	Between 100 & 200	1,340,038,600	16,305 11 10	2·92
8 (Table G)	Over 200 . . .	4,856,542,400	67,390 10 5	3·33
25 Totals .	..	6,557,446,000	88,539 4 7	..

Average rate of repairs and maintenance of works of 25 local authorities of all sizes, per 1000 cubic feet sold, 3·24d.

minimum of repairs are balanced by those engaged upon extensive alterations, and consequent writing off of abnormal sums for old plant displaced, &c. For example, the engineer of No. 8 in Table G writes me that they have been spending heavily on renewals and repairs. They have closed one works as a manufacturing station, and enlarged another works to the extent of three-quarters of a million cubic feet per diem. Yet, in spite of this heavy expenditure, the rate only works out at 7·63d. So far as the figures go, therefore, the conclusion to be arrived at is that not 4d., 5d., or 6d. is a fair rate per 1000 cubic feet to allow for repairs and maintenance, but a fraction over 3d.—certainly not more than 3½d. The total gas sold by 32 companies and local authorities was 62,119,939,000 cubic feet; and the repairs were carried out for £886,560, or 3·425d. per 1000 cubic feet sold. As these figures cover the operations of more than half the gas manufacture of the United Kingdom, they afford convincing proof that 3½d. per 1000 cubic feet is a liberal allowance for repairs and maintenance of works.

It was my desire to get out a similar analysis of maintenance and repairs of mains and meters; but the practices already alluded to, of unmercifully debiting revenue with meters for new consumers, precludes all possibility of arriving at a fair average from the balance-sheets. A bone of contention is still left, therefore, to the experts, even if 3½d. is accepted as a fair rate for the repair and maintenance of works.

Much could be said about rates and taxes. Most of us have looked with dismay upon the increasing amount under this head. With respect to the valuation of gas-works, the valuer of a neighbouring Board of Guardians told me in a patriarchal sort of way, that the best advice he could give to gas companies was to "lay low," for if they appealed against the valuation, ten to one it would be increased if the works were re-valued.

One phase of the income-tax business may be touched upon. While the Commissioners allow in private business a sum for depreciation, they insist—with us, at all events—upon charging income-tax upon all sums placed to depreciation in gas accounts. They certainly seem to be in possession of a good argument, in the assertion that gas companies are allowed, and expected, to maintain their works; and that if this is conscientiously done, there need be no depreciation. Acting on this advice, one company made certain that their meters did not depreciate by putting £200 for new meters to the repairs of meters, instead of charging it to capital. Under other circumstances, this sum would have been capitalized, and an equal amount carried to the depreciation fund. Income-tax saved, £6 13s. 4d.

We will pass on to the receipts side of revenue. Slight improvements could be effected in many balance-sheets. Some companies having prepayment meters do not separate them from the ordinary sales; while others give the receipts for gas-rental, but do not state the price charged or the quantity of gas sold equivalent to the amount received. Discount, too, figures as a cost or item of expenditure in some accounts, though the most accurate method of treatment is to deduct it from the gross amount of the gas-rental.

The following table will show how general the system of allowing discounts has now become. The accounts of 68 undertakings were examined, out of which 16 do not sufficiently define whether discounts are allowed or not. Of the remaining 52, the figures are as follows:—

	Local Authorities.		Companies.
Allow discounts	21	..	19
Do not allow discounts	7	..	5
Total	28	..	24

Therefore, out of 52 gas undertakings, no less than 40 allow discounts.

In the general balance-sheet or statement appear the sundry stocks of fittings, coals, &c. In this connection may be discussed the method of treating stoves on hire in the balance-sheet. Of 41 companies and corporations hiring out gas-cookers, 11 place the cookers to the stock account, 24 place them to capital, and 6 charge the cost to revenue without taking credit for the expenditure in stock. In placing the cost to capital, some depreciate and others do not. If an amount is not written off for depreciation periodically, the stoves can never stand at the full value at which they are capitalized after the first year. It may be suggested that, when one wears out, it would be replaced out of revenue; but still the bulk would be considerably less valuable than when first fixed and capitalized. Taken as stock, and depreciated by from 10 to 15 per cent., seems to me to be the most judicious way of treating them. Of 67 gas undertakings companies and local authorities), 41 have the hired-stove system in operation, while 26 have not; showing a big majority in favour of this means of increasing the consumption of coal and water gas.

With many accounts, a working statement is incorporated; and if there is one thing that will put a manager on his best behaviour it is to find that someone else is producing results considerably better than his own. One or two comments on those accompanying the accounts sent in to me may not be altogether unacceptable. One return gave a make of just over 11,000 cubic feet to the ton. But this was destined to be left far behind; for the perusal of another statement revealed a make of 11,514 cubic feet, and still another 11,595 cubic feet per ton, of which no less than 11,112 cubic feet were sold. It would be interesting to know by what means such excellent results are obtained, and what is the proportion of cannel used. The cost per ton of coal and cannel works out to a fraction over 11s. 8d. One large works is able to show a leakage account of only 2·13 per cent. It should be stated that the works in question supply a level district, and therefore they do not labour under the disadvantages accruing from varying levels and pressures.

These are results that are not extracted from the realms of fancy, but appear in plain black and white in the working statements of gas undertakings. Hitherto most of us—in fact, nearly all of us—have had to be content with dreams of them; and if an allusion to them here should ultimately result, through discussion, in the dream spectres being materialized, these remarks will not have been made in vain.

The PRESIDENT said, as it was very late, Mr. Brearley had given his sanction to his paper being brought before the next meeting for discussion; and, as he had prepared it very hurriedly, he wished to make an addition to it.

THE STANDARDIZING OF METER-UNIONS.

The PRESIDENT read a letter from the Secretary of the Incorporated Gas Institute (Mr. Walter T. Dunn), stating that the Council had unanimously passed the following resolution:

> That the Council consider it desirable that an application be made to the Board of Trade with the object of obtaining their recognition of a set of standards for meter-unions in the United Kingdom, but that before any action be taken a circular be issued to kindred Institutions and Associations asking for their views and co-operation in the matter.

It was the wish of the Committee to support the Institute in the application they proposed to make to the Board of Trade, and, therefore, he should be glad if the meeting would give their permission to this course being adopted.

The SECRETARY said it would be remembered that the question of the standardizing of gas-meter unions had been knocking about from pillar to post for some years. A paper was read on the subject at the meeting of The Gas Institute at Belfast,* and it was decided to leave the matter in the hands of the Council of the Institute. The Council were desirous of memorializing the Board of Trade to adopt a set of new standards for meter-unions; but they first of all wanted to know what other kindred Institutions and Associations were prepared to do in the matter. He would, therefore, propose—"That the Committee of this Institution be empowered to support the Council of The Gas Institute in any action they might take in the matter of memorializing the Board of Trade with regard to obtaining a set of standards for meter-unions in the United Kingdom."

Mr. TOWNSEND seconded the resolution, which was passed unanimously.

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* See *Journal of Gas Lighting*, Vol. LXXI., p. 1551.

VOTES OF THANKS.

Mr. G. E. STEVENSON proposed that a hearty vote of thanks be accorded to the Corporation of Bradford for having so kindly permitted the members to visit the chemical works that day, and to Mr. Charles Wood, the Engineer, for having escorted them, and given them every opportunity of seeing the processes of manufacturing the chemical products carried on there.

Mr. BREARLEY seconded the resolution, and it was passed unanimously.

Mr. WOOD having acknowledged the vote,

Mr. T. N. RITSON (Kendal) followed with a vote of thanks to Mr. Shadbolt for his "Notes on Purification," and also to Mr. Brearley for his communication on "The Balance-Sheet."

Mr. TOWNSEND seconded the resolution, which was supported by the SECRETARY, and passed unanimously.

Mr. BREARLEY returned thanks, and this concluded the business of the meeting.

Office-Bearers and Members

FOR

1898

EASTERN COUNTIES
GAS MANAGERS' ASSOCIATION.

President.

W. D. CHILD, Romford.

Vice-President.

H. WIMHURST, Sleaford.

Honorary Secretary and Treasurer.

J. H. TROUGHTON, Newmarket.

Committee.

J. E. BUCKLE, Woodbridge.
J. B. FENWICK, Retford.
J. G. HAWKINS, Spalding.
E. G. SMITHARD, King's Lynn.

Auditors.

C. E. ELLIS, Yarmouth.
C. PANCHEN, Yarmouth.

Members.

Ayris, J., Lowestoft.
Banham, C., Wymondham.
Barton, J., Peterborough.
Beale, W., Royston.
Beck, J., Stamford.
Best, W. J., St. Ives.
Bloodworth, D., Ketton.
Bridge, R., Doncaster.
Brockway, E. J., Cleethorpes.
Brown, R., Cambridge.
Brown, W., Brandon.
Brown, W. P., Southtown, Yarmouth.
Buckle, J. E., Woodbridge.
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Carpenter, W. J., Yarmouth.
Carter, J., Lincoln.
Casterton, G. R., Biggleswade.
Chapman, G. H., Stamford.
Chester, W. R., Nottingham.
Child, F. R., Halstead.
Child, W. D., Romford.
Clark, A. L., Maldon.
Clark, F., Southend.
Davis, J., Gravesend.
Dawbarn, R., Wisbech.
Dixon, C., Horncastle.

Dixon, J., North Walsham.
Dougall, J. S., Boston.
Drage, A., East Dereham.
Dunn, M., Goole.
Edwards, H. G., Gorleston.
Ellis, C., Yarmouth.
Fenwick, J. B., Retford.
Graham, A., Mansfield.
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Green, C., Market Rasen.
Green, H., Market Rasen.
Grimwood, C. G., Sudbury.
Grimwood, C. W., Sudbury.
Guyatt, T. A., Ely.
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Mason, J., Oakham.
Mitchell, A., Bury St. Edmunds.
Panchen, C., Yarmouth.
Parker, C. F., Beccles.
Pask, J. O., Ross.
Pike, H. S., Colchester.
Plowright, W. H., Swaffham.
Portass, J. W., Bishop's Stortford.
Prentice, F., Ipswich.
Rose, A. H., Wainfleet.
Row, C. J. N., Long Melford.
Shadbolt, R. G., Grantham.
Sharman, R. J., Wisbech.
Smith, E. W., Chelmsford.
Smithard, E. G., King's Lynn.
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